FISCAL YEAR 1986 DEPARTMENT OF ENERGY AUTHORIZATION

(Uranium Enrichment and Electric Energy Systems, Energy Storage and Small-Scale Hydropower Programs)

HEARINGS

BEFORE THE

SUBCOMMITTEE ON
ENERGY RESEARCH AND PRODUCTION

OF THE

COMMITTEE ON
SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

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CONTENTS

WITNESSES

Page

February 28, 1985:

Clive G. Whittenbury, executive vice president, the Erickson Group, representing the Tri-Committee Advisory Panel 3
Dr. John L. Emmett, associate director for lasers, Lawrence Livermore National Laboratory 13
George R. Jasny, vice president, engineering and computing, Martin Marietta Energy Systems Group, Inc 43
Kenneth W. Sommerfeld, vice president, enrichment/centrifuge, Martin Marietta Energy Systems Group, Inc 60
Richard L. Grant, president and executive director, Boeing Engineering Co. Southeast, Inc 70
Norman E. Whitchurch, general manager, centrifuge equipment division, Goodyear Aerospace Corp 88
Charles J. Rowan, director, enrichment systems, Airosearch Manufacturing Co 94
Dr. George W. Cunningham, director of the Mitre Institute, Mitre Corp..... 115
Arthur Lundvall, vice president for supply, Baltimore Gas & Electric Co., representing the Edison Electric Institute, accompanied by Loring E. Mills, vice president, Edison Electric Institute 123
Bill Stevens, president, Quivira Mining Co., Kerr-McGee Corp., on behalf of the American Mining Council 139

March 5, 1985:

James W. Vaughan, Jr., Acting Assistant Secretary for Nuclear Energy, Department of Energy; and John R. Longenecker, Deputy Assistant Secretary for Uranium Enrichment 158

March 7, 1985:

William Patrick Collins, Under Secretary, U.S. Department of Energy, accompanied by Donna Fitzpatrick, Principal Deputy Assistant Secretary for Conservation and Renewable Energy; Al Streb, Deputy Assistant Secretary for Conservation; and Dr. Robert San Martin, Deputy Assistant Secretary for Renewable Energy 226
Dr. Charles W. Lawrence, Institute of Electrical and Electronics Engineers, Inc., accompanied by William Lang, chairman of the Institute of Electrical and Electronics Engineers, Inc 249
Lowell J. Endahl, manager of energy research and development, National Rural Electric Cooperative Association 260
Dr. Gene G. Mannella, deputy director, Washington office, Electric Power Research Institute 273
Dr. Elton J. Cairns, associate director, Lawrence Berkeley Laboratory and professor of chemical engineering, University of California, Berkeley, CA 289
Roger S. Carlsmith, director, Conservation and Renewable Energy Program, Oak Ridge Laboratory, Oak Ridge, TN 307

APPENDIX I

ADDITIONAL STATEMENTS FOR THE RECORD

Addition to statement of Bill Stevens, American Mining Congress 317
Bernard S. Lee president, Institute of Gas Technology 318
Donald R. Glenn, director, program development, Energy Research Corp 320

APPENDIX II

SUPPLEMENTAL QUESTIONS FOR THE RECORD

Page

February 28, 1985:
- Clive G. Whittenbury, Tri-Committee Advisory Panel 324
- Dr. John L. Emmett, Lawrence Livermore National Laboratory 325
- George R. Jasny, Martin-Marietta 326
- Kenneth W. Sommerfeld, Martin-Marietta 330
- Richard L. Grant, Boeing Engineering Co 335
- E.O. Hartig, Goodyear Aerospace Corp 343
- Charles E. Rowan, AiRsearch Manufacturing Corp 346
- Dr. George W. Cunningham, MITRE Corp 352
- Arthur E. Lundvall, Jr., EEI 353
- Bill Stevens, American Mining Congress 358

March 5, 1985:
- James W. Vaughan, Jr., Department of Energy 372

1986 DEPARTMENT OF ENERGY AUTHORIZATION

THURSDAY, FEBRUARY 28, 1985

House of Representatives,
Committee on Science and Technology,
Subcommittee on Energy Research and Production,
Washington, DC.

The subcommittee met, pursuant to notice, at 1:15 p.m., in room 2318, Rayburn House Office Building, Hon. Marilyn Lloyd (chairman of the subcommittee) presiding.

Present: Representatives Lloyd, Valentine, and Morrison.

Mrs. Lloyd. The Subcommittee on Energy Research and Production will come to order. I am very sorry about our delay today but it's good to have you all here today at the hearings.

The pair of hearings which will begin today will cover a most important issue. That is no less than the question of the future of the U.S. uranium enrichment enterprise. We are in the unusual position of hearing from outside witnesses before we hear from the Department of Energy on this issue, but I don't believe that that will in any way impair our ability to better understand the issues.

I have identified four principal concerns which have emerged from our subcommittee's oversight of the uranium enrichment program. These four critical areas are, one, the technology selection between AVLIS—atomic vapor laser isotope separation—and the AGC—advanced gas centrifuge—and the associated deployment schedule; two, the operation of the gaseous diffusion plants in a cost-effective manner, and mechanisms for reducing the DOE cost of electricity; third, the modified deployment plan for the gas centrifuge enrichment plant and the manner in which the Department intends to implement the plan; and, fourth, the decisionmaking process on the part of DOE and whether they have indeed made a good faith effort to conduct the enterprise in a businesslike manner despite some major administrative constraints.

Now beyond these obvious programmatic issues and the related business decisions of the enterprise, there are larger policy issues which challenge the Department of Energy. The first of these is what actions can the United States take to assure other countries that we intend to once again prove ourselves a reliable supplier of enrichment services. Also, I believe that the decisions taken with respect to the enterprise will answer some of industry's questions about the relative certainty of any Federal nuclear policy.

For instance, does the Federal Government weigh the great investment in funding and people which companies have committed over the long haul to develop a reliable supplier infrastructure, or will decisions be based almost solely on near-term budgetary aspects? Further, can the Federal Government successfully operate a business which must be geared to meet intensive competition in the modern international market? Finally, the administration must also answer the question as to whether the Federal Government can carefully and responsibly decrease its presence in certain areas of the country rather than "stealing away into the night," thus wreaking great socioeconomic havoc.

There is no more challenging budget and oversight matter for this subcommittee than the decisions affecting the future of the uranium enrichment enterprise. We must approach this complex decisionmaking process with open minds and great care, as I reminded Secretary Herrington earlier this month. It is no exaggeration to claim that calendar year 1985 will mark the major turning point for the future of the United States uranium enrichment enterprise. Let us hope that all those involved are capable of making the right choices.

We do have an excellent set of witnesses today, including a number of very good friends.

Before we do call on our witnesses, I would like to call on the ranking minority member of our committee, Mr. Morrison.

Mr. MORRISON. Thank you, Madam Chairman.

I am looking forward to these hearings. I need to learn a lot about this issue, and as I look down the complement of witnesses I am very confident that I will have that opportunity.

I approach uranium enrichment as an outsider, having little background in the DOE enrichment services program. In fact, I have had an active interest in all aspects of the nuclear fuel cycle except for enrichment. Today's hearings will help me fill in those critical gaps.

I would like to, at this stage, approach uranium enrichment from a fresh viewpoint which will focus on two essential principles: first, finding the best technology at the best price, and running our programs in the most profitable manner. I am particularly interested in the technology choice between the Advanced Gas Centrifuge and the Atomic Vapor Laser Isotope Separation. DOE is facing a difficult choice, and I urge the Department to base their ultimate decision entirely on which concept offers our Nation the superior and the most cost-effective technology.

I'm also encouraged by the businesslike approach taken by the Department of Energy to ensure that our enrichment service expenditures match our revenues. The new utility service contract is a sign that the Department is striving to avoid shortfalls in our revenues. We have lost our once-dominant position in the world market, and I hope that with this new contract approach and other businesslike dealings on the part of the Department, we can win back enrichment consumers while protecting the interests of the American taxpayers.

These two concerns—selecting the best technology and improving our revenue situation—will govern my thinking during these hearings.

Thank you, Madam Chairman, for this opportunity. I look forward to the witnesses.

Mrs. LLOYD. Thank you very much, Mr. Morrison.

Before we call our first witness I am going to take the prerogative of the chairing member. There is a very important person with us today, and that special person to me is my daughter. Nancy, would you stand? We would like to welcome you to our hearing today. Thank you very much.

Mr. Whittenbury, we are just very happy to have you with us today. You represent the Tri-Committee Advisory Panel which reported to the Congress last year. Your written testimony will be included in the record. You may summarize or proceed just as you wish. Thank you for being here.

STATEMENT OF CLIVE G. WHITTENBURY, EXECUTIVE VICE PRESIDENT, THE ERICKSON GROUP, REPRESENTING THE TRI-COMMITTEE ADVISORY PANEL

Mr. WHITTENBURY. Thank you, Madam Chairman and members of the subcommittee. I am very pleased to respond to your invitation to testify today on the proposed management of the uranium enrichment program.

My comments will specifically cover the usefulness of the contributions made by that business advisory panel, the panel of course having been convened by your committee and the Committees on Energy and Commerce and on Interior and Insular Affairs. We met once in August and we have met subsequently twice with the members of the PEB of the Department of Energy.

The usefulness of our contributions depended very simply on whether we had anything to say and whether the DOE did anything about what we had to say. In simple terms, I am happy to report that we were successful on both counts.

You have asked for our comments on DOE's proposed management of the enrichment program, in the context of our report to the committees, and specifically for an assessment of the DOE efforts to comply with the major recommendations of the panel's report.

Now as a preface to my comments, I think it would only be fair to say that the panel's exposure to the enrichment program has been quite brief and really quite miniscule compared with the amount of effort that has been put into the program by DOE and its contractors. We would not wish to be presumptious about the depth and the priority of all of our findings and recommendations. The responsiveness of DOE might then be measured best in the process that they have followed and in the way in which they have listened to and worked with our suggestions. From the evidence to date, for example the two workshops, I can assure you that the Department of Energy has been impressively responsive.

Among the recommendations that were made in the panel's report, we suggested to the DOE that the Process Evaluation Board—the PEB—consider the business issues that we highlighted in our report. We emphasized the importance of the activities of the PEB in influencing the future business success of the enrichment enterprise and, as a direct response to those suggestions, the Department of Energy held two workshops for the Process Evaluation Board. These two workshops were very constructive meetings which were characterized by frank, useful, and specific discussion of the business issues faced by the DOE, and issues that the panel members had raised previously.

Through these workshops and other ongoing efforts that we are generally aware of, the DOE has built upon the congressional initiative that convened the panel last year in August. Members of the panel are most pleased that the time that we have given to the congressional committees and subsequently provided to the PEB has been used effectively, and that this has been done both competently and constructively.

Going back to what the panel said in its report and how DOE has responded, I thought it would be most useful to you and the simplest thing to do, to go down our major headings in the report and comment on those. They number five: general findings; organization and management; technology selection and acquisition; marketing; and cost reduction.

In our view, first and foremost in the general findings we emphasized the importance of the marketplace. It is fundamental to evaluating the new technologies, fundamental to determining the capacity of plants required in the future, and certainly in developing the overall business strategy of the uranium enrichment enterprise.

In its response to this major comment, DOE has strongly increased its effort in market analysis and has taken a much broader view of the marketplace, what is needed to be competitive, including pricing approaches that are commercially oriented, and they have made substantial progress in our view in developing a new view of the marketplace itself. This is translated into reviewing the sizing of plants and looking at what the elements really should be of a sound business strategy.

Going to the second heading, organization and management, our recommendations focused on the need to establish a private business management structure. I'm trying to be precise in those words because I think the panel feels that there are too many superficial uses of the word "privatization" in talking about the role of free enterprise in looking at Government business, and that one has to be very precise in talking about what "privatization" really means and how it might be included in a program like this. We believe it is particularly important for the uranium enrichment program, which is a very good opportunity for doing things right, in a businesslike way, and having the country catch a few "Brownie points" for doing it first out of Washington.

The problem, however, in looking at the private business management structure is that the enrichment enterprise today is characterized by an entrepreneurship and a richness of outstanding and dedicated talent. What I mean by that is the qualifications of individuals that we have been exposed to, both in Government, in the labs, in the contractors, who are all talking about their assignment in a businesslike way, and obviously they are extraordinarily competent people.

What I think we are concerned about, with this envy of any private business, is how do you keep these qualities alive now that major changes are in the offing and that the program is obviously subject to normal Government procedural constraints? These changes are the changes to the technology, the threat of major competition in what you might refer to as a collapsing marketplace, and the impact on existing plants in the enrichment business. In the private sector these kinds of problems are typical. You live with them every day. Change is the order of the day and it's not a big deal to handle them through normal companies.

We discussed privatization of the enterprise and agreed it is not a simple matter. Instead, we felt that it would be more useful, near-term, in precisely defining privatization, to look at elements of private business practice and introduce them carefully and effectively into the program. We recommended that DOE take these matters under study, and I believe it's too early to ask for results today.

The third heading, technology selection and acquisition, included those recommendations which were of direct interest to the Process Evaluation Board—and obviously they are looking at the technology selection. The PEB made a very effective response in working with members of the panel in our two meetings and, in summary, the panel believes that on the technology decision the chosen date of May 1985 has been very useful in focusing on decisions issues and the process for reaching that decision.

We suggested that certain business issues be introduced into the technology decision process. These issues have been discussed in depth at the workshops and were introduced into the program by the PEB with the May 1985 decision date in mind. These specific issues covered plant sizing, deployment schedules, product pricing, the uncertainties inherent in the introduction of any new technology into an industrial process, and what private industry might indeed do about these particular issues, how we might look at them.

We have commented several times on the importance of the marketplace and how marketing might be done in this particular program. We feel the key word here is "is"—that marketing should be done as it is done in the private sector, and that that should be considered very seriously by all of the parties.

Our final set of recommendations dealt with cost reduction. Now we commented on the obvious. Actions in this area, however, we feel are the ongoing business of the DOE with your committees. Specifically what I'm talking about are operation of plants with capacity well in excess of market requirements—this is obviously a matter for scrutiny—as is the continuing deployment of any technology which represents any intermediate state of the art into facilities that may or may not be needed.

Private business, through financial necessity and the unpleasant consequences of making serious investment mistakes, might have dealt with some of those problems some time ago. Without the threats normally found within private business, however, DOE does appear to be dealing with these very difficult problems. That's a very good sign and we believe it speaks well for the future of the program.

Now the uranium enterprise has all the ingredients of a large commercial industry. It has been operated successfully in the past using technology that must be displaced in the future by significantly more efficient technology, and that technology is now almost in hand. Some important decisions about its financing and deployment must be reached.

The process should involve the basic business issues that the panel members have addressed. Thinking commercially in a Government environment is not easy. Acting commercially in that environment will be even more difficult and will be professionally risky for those members in Government, particularly DOE, who wish to try and do it properly. DOE will need all of the encouragement that they can get, and they will need effective political support as they make those attempts. I believe that DOE has responded by preparing the right groundwork. Now the committees should, obviously, be alert to see where they can help to see that DOE has the chance to make it work.

For this hearing you asked if we felt that the program plans provided a good long-term strategy for the Uranium Enrichment Program. We believe that excellent steps have been taken toward that strategy. Nevertheless, there is a lot more hard work to be done and, obviously, tough decisions to face. In the last year, particularly through the constructive initiatives of your committee and the other two committees, the hard work required and the decisions have been clarified.

I am almost finished.

I am sure that I speak for all members of the panel in saying that we are honored to have been able to contribute in our own small way to the progress that has been made.

If my comments sound a little like a pep talk, I make no excuse. This is a business in which the United States must place first for political, technological, and business reasons. Between Congress, DOE, and industry you have an opportunity to establish a very effective national enterprise, one which will both justify the taxpayers' investment in the past technology and which will see a fair return for the taxpayer in future years.

Thank you very much.

[The prepared statement of Mr. Whittenbury follows:]

Statement of

Clive G. Whittenbury

Executive Vice President
The Erickson Group
Member Tri-Committee Business Advisory Panel

Before the

Committee on Science and Technology

Subcommittee on Energy Research and Production
U.S. House of Representatives
February 28th, 1985

Chairman Lloyd, members of the subcommittee, I am pleased to respond to your invitation to testify on the proposed management of the Uranium Enrichment program. My comments will cover the usefulness of the contributions made by the Business Advisory Panel. This Tri-Committee Panel was convened by your Committee and the Committees on Energy and Commerce, and on Interior and Insular Affairs, and met in August 1984. Subsequently, members of the Panel met twice in workshops with the Department of Energy.

The usefulness of our contributions depended on whether we really had anything to say, and whether the DOE has done anything about what we had to say. I am happy to report that we were successful on both counts.

You have asked for comments on DOE's proposed management of the Uranium Enrichment program, in the context of the Tri-Committee Advisory Panel's report to the Committees, and specifically for an assessment of DOE efforts to comply with the major recommendations of the Panel's report.

As a preface to the comments below, it would only be fair to say that the Panel's exposure to the Enrichment program has been quite brief, and that we would not wish to be presumptuous about the depth and priority of all our findings and recommendations. The responsiveness of DOE might then best be measured in the process they have followed and in the way in which they have listened to and worked with our suggestions. From the evidence to date, for example the two workshops, I can assure you that DOE has been impressively responsive.

Among the recommendations made in the Panel's report it was suggested that the DOE Process Evaluation Board (PEB) sizes, and in defining elements of a sound business strategy.

Organization and Management recommendations focussed on the need to establish a private business management structure, to write specific business objectives for the enterprise, and to introduce long-range financial planning with the appropriate commitments over several years (not on a year to year basis). The Enrichment Enterprise is characterized by entrepreneurship and a richness of outstanding and dedicated talent. It would be the envy of any private business. The question is how to keep this alive now that major changes are in the offing. Changes to new technology, the threat of major competition in a collapsing marketplace, and the impact on existing plants. These problems are typical in the private sector, where change is the order of the day and a corporation is ready to deal with them. We discussed privatization of the Enterprise and agreed that this is not a simple matter. Instead, we felt that it would be more useful, near-term, to introduce elements of private business practice. These would allow longer term business stability, rapid response in the marketplace and incentives for the management. We recommended that DOE take these matters under study, and it is too early to ask for results now.

Technology Selection and Acquisition of new plant included those recommendations which were of direct interest to the Process Evaluation Board. I have already referred to the PEB and the effective response that they have made to our suggestions. In summary, the Panel believes that the technology decision date of May 1985 has been very useful in providing a focus on the decision issues and the process for reaching that decision. The Panel suggested that certain business issues be introduced into the technology decision process. These issues were discussed at the workshops, and have been introduced into the program with the May 1985 decision problems in mind. They covered plant sizing and deployment schedules, product pricing, the uncertainties inherent in the introduction of a new technology in any new industrial plant, and what private industry might do about these matters.

We have commented several times on the importance of the marketplace and implied that marketing must receive a strong focus and perhaps a different organizational treatment. It has been suggested that marketing be done as it is in fact practised in the private sector. This is a matter for future action and one in which the Committees might be able to assist.

The Panel's final set of recommendations dealt with Cost Reduction. While we commented on the obvious, actions in this area are the ongoing business of the DOE with your Committees. Operation of plants with capacity well in excess of market requirements is a matter for scrutiny, as is the continuing deployment of technology which represents intermediate state-of-the-art into facilities that may or may not be needed. Private business, through financial necessity and the unpleasant consequences of making serious investment mistakes, might have dealt with those problems some time ago. Without the threats normally found within private business,however, DOE appears to be dealing with these difficult problems today. That is a very good sign, and speaks well for the future of the program.

The Uranium Enterprise has all the ingredients of a large commercial industry. It has operated successfully in the past using technology that must be displaced in the future by significantly more efficient technology. That new technology is now almost in hand, and some important decisions about its financing and deployment must be reached. That process should involve the basic business issues that Panel members have addressed.Thinking commercially in a government environment is not easy - acting commercially will be even more difficult and professionally risky. But it must be done. DOE will need encouragement and effective political support as it makes its attempts. So far, DOE has responded by preparing the groundwork. Action is now required, and the Committees should watch for it.

For this hearing you asked if we felt that the program plans provide a good long term strategy for the Uranium Enrichment program. We believe that excellent steps have been taken toward that strategy. Nevertheless, there is a lot more hard work to be done, and tough decisions to face. In the last year, particularly through the constructive initiatives of the Committees, the hard work and decisions have been clarified. I am sure that I speak for all members of the Panel in saying that we are honored to have been able to contribute in our own small way to the progress that has been made.

If my comments sound a little like a pep talk, I make no excuse. This is a business in which the United States must place first and stay first for political, technological and business reasons. Between the Congress, DOE and Industry you now have the opportunity to establish a very effective national enterprise, one which will both justify the taxpayer's investment in past technology and which will see a fair return for that taxpayer in future years.

Mrs. LLOYD. Thank you very much, Mr. Whittenbury. Don't apologize at all for a pep talk. We need lots of those here. You have been very positive and straightforward. I want to thank the advisory panel for the good work they did and the sacrifices that you have made to put that time into your commission.

You referred in your testimony to the fact that DOE should operate in a more businesslike manner. Are there other measures that you think they could take to operate more efficiently, in a more businesslike manner?

Mr. WHITTENBURY. There are always additional things that could be done, yes.

Mrs. LLOYD. I mean really big things, big tickets.

Mr. WHITTENBURY. Yes, there are, and it's not going to be easy for them to do it. I go back to the word "marketing" and the marketing capability, the market analysis capability. In private business that's a very large portion of one's overhead. I think when you look at the size of this program and look at how much effort and budget is devoted to general administrative functions that refer to business activities, they are miniscule. I think that's something that something dramatic has to be done about, because this is not a place where we have a choice any more. We are in a deadly competition with Europe, and in the future the Far East.

Mrs. LLOYD. This is an area, unfortunately, that really we can't take into account.

Mr. WHITTENBURY. We understand.

Mrs. LLOYD. The GAO has said that DOE's writeoff of certain GDP expense and depreciation violated the Atomic Energy Act, but DOE disagrees with that and says that the writeoff is consistent with the act and good accounting principles. Since we are going to try to be more businesslike, and from a business point of view, do you agree that this form of depreciation is appropriate for a writeoff? I mean, we can't be all things on both sides.

Mr. WHITTENBURY. Right. First of all, I can't make any comment that has legal consequences or legal basis. I can just tell you what private business does.

Mrs. LLOYD. As a businessman, not as a lawyer.

Mr. WHITTENBURY. Private business writes off obsolete plant as quickly as they can.

Mrs. LLOYD. That's the point I was trying to make. How can we operate like a business when we are constrained to the point that we can't operate?

Mr. WHITTENBURY. Change the law.

Mrs. LLOYD. I think that might be a good thing to do.

The Department of Energy cites a number of obstacles—let me go back to that statement. Maybe they better interpret the law. The Department of Energy does cite a number of obstacles as to why they can't operate as a private business manager as you have recommended. Of course, it takes large financing requirements, long payback periods, and we don't know what the different administrations are going to come up with, what the nuclear role is going to be and what the fierce competition might do. They are really big show stoppers.

It seems to me that we really can't operate it effectively unless they can write off most of the gaseous diffusion and other advanced technologies. So my question to you is, why do you support privatization of the enrichment enterprise in spite of the fact that the Government must write off a large fraction of its investment that would have to be transferred to the private sector? I mean, we can't have this both ways.

Mr. WHITTENBURY. I would try and answer that in three simple steps. I would be specific about privatization and focus on marketing as it's done in the private sector, and I would focus on financing. That doesn't have to be done in the private sector but it should be done as if it were in the private sector. That's point 2.

Point 3 is that if we're looking to this as if it were a private business, we have to keep the investors in mind. The investors in this case are the American taxpayers, and there has to be an approach worked out in which the tax break, in which the taxpayer gets a future break and a return on the profits that will be made from what promises to be a very good commercial industry. So I don't think the writeoffs are the issue but the payback to the investors is the issue, and that's something that can be planned and negotiated and promised, but it has got to be done realistically.

Mrs. LLOYD. Thank you very much.

Mr. Morrison.

Mr. MORRISON. Let me ask a question, then, Mr. Whittenbury, that maybe shows that I'm a beginner in this subject area. Why don't we just completely privatize the whole process, make a complete break?

Mr. WHITTENBURY. I guess I will start with the suggestion that I made, which is to take it in pieces, specifically those pieces which I believe are feasible, looking at the marketing which is an adjustable problem and looking at financing which is a very specific problem.

When we talk about putting the whole program into the private sector, presumably you are talking about the possibility of selling stock to the outsider, letting it be managed purely as if it were a private business. That is a very, very large elephant to digest in one shot. I think there would be so many problems involved because it is sensitive material, it's tied in with the weapons program, one part of it. There are a whole series of issues which make it very, very difficult to untie and put up for sale, and I believe that the panel members unanimously felt that the best service that could be done for the privatization concept was to turn it from a superficial concept into something very specific, very feasible, and done step by step.

Perhaps I have not answered your question as thoroughly as you might like.

Mr. MORRISON. I think your reaction is most logical and I appreciate that. I do recognize some of the difficulties and know how sensitive that we are to this in this Government.

I am wondering, did the panel look at all at the new utilities services contract which was developed?

Mr. WHITTENBURY. No.

Mr. MORRISON. I am not sure, does your panel continue to be in existence? Have they completed their charge to the committees?

Mr. WHITTENBURY. No. I'm not sure what our legal status is but we were invited by the committees for that original session in

August, and then we have been asked individually to go to these workshops to explain why we said what we did, and we were happy to do that. I'm not sure what our official status is. I don't think we are a panel any more.

Mrs. **Lloyd**. You are not decommissioned?

Mr. **Whittenbury**. I'm sorry?

Mrs. **Lloyd**. I don't think we would classify you as "decommissioned."

Mr. **Morrison**. We will probably decommission them and send them to Hanford, Madam Chairman.

If the panel continues or if you meet again, I personally would be interested in the reaction to this utility services contract which in some ways seems to fit the pattern. At least one of my questions would be, is it consistent with the overall direction of moving toward the more businesslike approach to operation and sales?

Mr. **Whittenbury**. I think that would be a difficult thing for us to do, because now you're talking about a specific contract and we were convened to talk about principles in business. We are, I'm sure—individually, speaking for myself, I don't mind talking about anything, but I also would be the first to say that I would probably be the least competent to comment on a utility contract.

Mr. **Morrison**. You've done such a good job that we want to stretch you a little further.

Thank you very much, Madam Chairman.

Mrs. **Lloyd**. Thank you very much, Mr. Morrison.

Mr. Valentine.

Mr. **Valentine**. Madam Chairman, I don't have any questions. I would like to express my appreciation to Mr. Whittenbury for what he and his colleagues have done and will continue to do.

Mr. **Whittenbury**. Thank you, Mr. Valentine.

Mrs. **Lloyd**. Thank you again for being with us. We certainly hope to be seeing you in the near future.

Mr. **Whittenbury**. Thank you, Madam Chairman.

Mrs. **Lloyd**. Our next witness is Dr. John Emmett, who is the Associate Director of Lawrence Livermore National Laboratory.

We are awfully happy to see you with us today, Dr. Emmett.

Dr. **Emmett**. Thank you very much.

Mrs. **Lloyd**. It's good to have you. We do have your complete testimony. It will all be included as part of the record, so you can use your good judgment and proceed, and know that all of the valuable material that you sent to us will be in the record.

STATMENT OF DR. JOHN L. EMMETT, ASSOCIATE DIRECTOR FOR LASERS, LAWRENCE LIVERMORE NATIONAL LABORATORY

Dr. **Emmett**. Well, thank you very much. Madam Chairman, members of the committee and staff, it's a pleasure to be here again today. I would like to take this opportunity, if I can, to introduce you to somebody who I don't think you have met before. That's Jim Davis, sitting behind me.

Mrs. **Lloyd**. Mr. Davis, it's a pleasure to have you with us.

Dr. **Emmett**. Jim Davis is the man in the trenches, leading this 24-hour-a-day activity to try to pull off this demonstration of this technology by May.

Mrs. LLOYD. We really don't ask for 24 at this point.

Dr. EMMETT. If I could, I think I would like to speak from the viewgraph machine. That would be a little easier.

Mrs. LLOYD. That would be fine with us. If you are going to use the viewgraph, I would like for it to be arranged so that as many that are in—OK. That would be fine. On the wall there we all can see it.

Dr. EMMETT. Is there a microphone over here or should I—I'll just speak fairly loudly.

Mrs. LLOYD. Oh, no; we have to have the microphones, so we'll have to move a microphone over because the stenographer can't—you'll have to take it over with you. Just pick it up and take it with you.

Dr. EMMETT. Yes; I think that will reach. OK?

The first thing I would like to do is to remind you of what Atomic Vapor Laser Isotope Separation is, and I can do that with the first viewgraph here. I think it would be easier if I sat down.

In the lower right-hand portion of the viewgraph is the vaporizing section where the uranium metal is vaporized, and it flows up between the collector plates. In that region the laser beam selectively photoionizes the uranium U-235, which is drawn over to the product collector, and the tails, the uranium U-238, streams through and collects on the tails collector on the top plate there.

Now the laser beams that do this activity are generated by dye lasers. Dye lasers are very, very much like conventional lasers. They use dyes like day-glow orange and those dyes are excited by pump lasers that operate in green, which we show there as pump lasers, so we have two pieces of laser technology that produce the laser beams and photoionize the material. That is, very simply, the way the AVLIS process works.

Now when I testified before you last year I made several points which I think I would like to reiterate this year because our positions on these matters have not changed, they have simply grown stronger.

First of all, I told you last year that we could have a full-scale plant prototypic operation of the AVLIS laser process by 1987. That still holds today, and we think we can do that at full scale in that timeframe.

The second thing I told you, specifically at your question, was that the cost of this process when fully deployed would be on the order of $100 million per million separative work units per year of installed capacity, and that the price of separative work would be about $25 per separative work unit, with a low estimate being $15 and a high estimate being $40.

Mrs. LLOYD. Would you repeat those again? I want to write them down.

Dr. EMMETT. Yes; I testified before you last year that the capital cost of a fully installed AVLIS plant would be approximately $100 million per installed 1 million separative work units per year capacity, and that the price of separative work would be $25 as the most probable cost, with the low side being $15 and the high side being $40.

We have done a lot more detailed analysis of plant designs in the intervening year, and those numbers look good today. As a matter of fact, it looks to us like the technical innovation is staying ahead of the rate of inflation, so it's the same in today's dollars as it was in last year's dollars. I think that's a very attractive situation.

I want you to understand that we don't work on AVLIS as just an alternative way of separating isotopes. We work on AVLIS as a way to bring the country low-cost separative work, that is, low capital investments and low separative work cost. Let me now summarize for you where we are in doing the demonstration as the basis of the selection process this year.

May I have the next viewgraph?

This viewgraph shows the uranium enrichment facility that we have been building at the Lawrence Livermore National Laboratory. That facility is about 90,000 square feet, to give you an idea of the size.

Could I have the next viewgraph, please?

This viewgraph shows a conceptual layout of that particular facility. In the center, the long chamber is the full-scale uranium enrichment chamber that is associated with the full scale plant demonstration. The blue long bars that you see in there are representative of the copper vapor laser, and the tunnel is representative of the dye laser installation that is being currently installed in order to do the separation demonstrations, and it's also required for the full-scale demonstration.

Could I have the next slide, please?

This is a little hard to see with all of the lights on in the room, but this is the full-scale vacuum chamber associated with the full-scale plant prototypic operation, that is being installed in the lab right now. It is being fabricated by Chicago Bridge and Iron.

May I have the next viewgraph?

Now as we told you last year—excuse me—these are the high-voltage power supplies that run the uranium vaporizers and the collector for the full-scale plant prototypic separation.

Next slide, please?

Now this viewgraph shows you the uranium separator chamber that we are actually going to use for the demonstration this year. I think we told you when we testified last year that it was not possible to have a full-scale plant prototypic operation before 1987, but that we had facilities where we could do approximately a half-scale shortrun demonstration.

Mrs. LLOYD. How much demonstration do you think will be necessary before going into production, if AVLIS were to be selected as the technology?

Dr. EMMETT. Well, madam, if we were selected, we would strongly recommend that we go through the full-scale plant prototypic demonstration before the money is spent to do the construction on a full-scale plant.

Mrs. LLOYD. Is this included in your cost? Is it included in your cost?

Dr. EMMETT. Yes. You will see in the plan I will present to you in a moment that not only do we believe that full-scale prototypic operation is desirable before we run the plant, but that we want to run all of the components through a large number of full plant operating cycles to fully define costs before we commit full construction costs——

Mrs. **Lloyd**. Thank you.

Dr. **Emmett** [continuing]. But I'll show you that in just 1 minute. So this is the half-scale facility we call MARS that we will be doing the experiment in in April.

May I have the next viewgraph?

We have several facilities for materials handling in the laser isotope separation program, and this shows the large MHDM facility where we are working out the problems of vaporization and liquid handling. This operation is being conducted by Martin Marietta Energy Systems in Oak Ridge. Thus far, this system has achieved operating times of 25 percent of a plant cycle, and we think that over the next 18 months if the program continues, we will achieve 100 percent plant cycle operating times in this facility. It's quite an accomplishment.

May I have the next viewgraph, please?

I would like now to switch to the laser facilities that are being installed. As you know, we are installing a very large, high-power laser facility at Livermore to run these demonstrations. This shows the fully-integrated lasers, power supplies, control systems and gas handling systems that are the system that comprises what we call the copper vapor pump laser. These are being assembled in large quantity at the laboratory right now and are being installed in position.

Could I have the next viewgraph, please?

This shows those large copper vapor lasers being installed in the support structures down the corridor in the laser isotope separation facility at Livermore. That activity is—well, it's even further along than this photograph shows right now. It is this facility that we will be using for the demonstration.

Now because we have to use the half-scale separator module to meet this time schedule, we have to take the laser light from the laser facility across the Livermore site to where the half-scale separator is located because there was no place to put the lasers in that area of the site, so we have a pipe that goes across the site. You can see that black line. It's about a 20-inch diameter evacuated pipe and associated optic control system that pipes the laser beam, underground from the laser laboratory and over to the separator. All of that has been installed since we talked to you last.

Could I have the next viewgraph, please?

I want to summarize exactly the parameters that we see a plant, fully designed, as having today. As you know, as part of the selection process in the last year, we have had industrial design and costing teams working on costing out the full design and the operating costs and so forth of this facility. Down at the bottom of this viewgraph, it says the work was done by Livermore, Bechtel, Stone and Webster. Also Martin Marietta Energy Systems was a very large contributor to this work, and unfortunately their name got left off the viewgraph.

But what it shows is, we are talking about a plant on the order of 12 million separative work units per year capacity that has an operating cost of about $200 million a year. It has a capital cost of——

Mrs. **Lloyd**. Pardon me, if I may interrupt you one more time.

Dr. **Emmett**. You bet.

Mrs. LLOYD. I'm a little bit confused here. Is the cost that you quoted at $25 a SWU based on your previous investments made in the technology as well as the forward costs that are necessary for deployment? If DOE says we've got to do this on a businesslike basis, then it has to go backward and forward, doesn't it?

Dr. EMMETT. Right. OK. The costs I'm talking about here are the costs the way the Process Evaluation Board has defined them. In this particular case what we're talking about is the full construction cost of the facility and the full operating costs of the facility, including the cost of feed conversion to metal.

Mrs. LLOYD. Yes, but that doesn't include the development costs.

Dr. EMMETT. Let me explain to you what the development costs are. The development costs are a little over $300 million to this point and $375 million to go forward with, so if you want to lump those costs together—say all of the development costs to date and so forth—it probably adds $4 to $6 a separative work unit. That is not a portion of the costing basis that I am presenting today.

To get an equivalent cost for the other technologies, of course, you would have to go back and integrate the entire R&D cost in the centrifuge program and the——

Mrs. LLOYD. That's what I'm trying to collect.

Dr. EMMETT [continuing]. And so forth.

Mrs. LLOYD. That's the data I'm trying to collect.

Dr. EMMETT. Well, let me submit the numbers properly for the record.

Mrs. LLOYD. I would appreciate it if you would.

Dr. EMMETT. I think we have invested today between $300 and $400 million in R&D to date. We see another $375 million being expended before we would commit full-scale construction funds to an operating plant.

Mrs. LLOYD. I would like to have the investments as well as the forward costs, if I could.

Dr. EMMETT. I will do that. I will submit that for the record.

Mrs. LLOYD. Thank you.

Dr. EMMETT. These numbers just summarize what I said to you verbally, which is the same as last year: that is a production cost of $25 a separative work unit, and that includes the capital amortization for the construction of the plant as well as the actual operating cost of the plant. Just to give you an idea, there is $8 or $9 in there in capital amortization for the plant and $16 or $17 or so in operating costs. It also includes the costs of feed conversion.

You see we are talking about $1.2 billion there, which is essentially the $100 million per 1 million separative work unit installed capacity that I talked about before. These costs are very, very similar to the ones that we have been generating in plant designs every year now for several years in a row, and it is very, very gratifying to us that these large-scale engineering firms who have been involved in the details of this have essentially validated our earlier projections.

Could I have the next viewgraph, please?

To go forward from this particular point, we are presenting the following schedule which we have also presented to DOE, which shows that we can bring a full-scale pod into operation in 1986 and by the end of 1987 we can have essentially a full plant prototype operating. Now between the end of 1987 and 1988 we would have 1 full year of operating time on all plant components before we committed to the construction of an actual separation plant which you see on the lower lines.

What does 1 full year mean to us? The shortest lifetime component in our system is the separator pod itself.

In this 1 full year of operation we will take three separate separator pods and we will run them through 10 full plant cycles each, 10 full economic lifetime plant cycles each, which means we will have essentially 30 cycles—full plant economic cycles—on the short-life component. This is statistically sufficient to define the cost of separative work due to that component to the 90-percent confidence level, so in 1 year of testing we will be able to define the cost to the 90 percent confidence level for operating cost. That is one of the very attractive features of the AVLIS technology: That is, the high-performance components are short-life and therefore they can be tested over their full economic life in a very short period of time.

As I mentioned earlier in the testimony, we have structured this so there is plenty of time to test all plant components before you commit significant construction funds to a plant. We would not recommend that you commit significant construction funds to a plant in either the AVLIS technology or the AGC technology without full economic lifetime demonstration of the critical components.

May I have the next viewgraph, please?

Now what I want to address next is how AVLIS would fit in the context of the uranium enrichment enterprise. Assuming that a decision was made to proceed with AVLIS, we would essentially have the gaseous diffusion plants and AVLIS to carry the enterprise forward.

What is shown in the upper band is the projected DOE price range for separative work out to the turn of the century, and what we have shown in black is the operation of the diffusion plants and then the tailing off of the operation of the diffusion plants as the AVLIS capability comes on.

Now the black line here is the cost of sales as we are pursuing this particular campaign and, as you see, right now, today the cost of sales and the projected price are of course the same number. If we closed out the AGC program and were pursuing just diffusion and AVLIS, the cost of sales would come down, and you see the dramatic reduction in the cost of sales that are essentially made by the AVLIS process.

One last viewgraph, please.

This just shows the projected revenue range from the January projection of DOE, and it has of course the same range and uncertainty. Now the lighter shaded color shows the projected range of DOE cash outlays if they operate the diffusion plants and if they proceed to deploy AVLIS.

As you can see, in the mid-nineties the gap between the cash outlays and the income gets very large. That very large income you are now producing because of the low cost of separative work from AVLIS can be used to pay back the Treasury in the case that Clive Whittenbury mentioned, that the stockholders, which are at the moment the American people, ought to get paid back somehow. So you can pay back the Treasury with that and therefore retire debt. You can use it to construct new facilities, or you can use it to reduce price to your customers. But what we would like to show is that the AVLIS program as planned fits within the planned revenues very conveniently.

Now since I testified before you last year, two things have happened on the international scene which I would like to mention. The first, the French have publicly announced that they are canceling their centrifuge program where they had tested subcritical rotors with advanced materials, and are turning their resources into the advanced technologies—the laser technologies and the plasma process technology. They are spending at a rate this year of 250 million francs a year, which in effort corresponds to about $40 or $50 million a year on our terms.

They claim they are going to make a process selection between the three processes that we chose between 2 years ago, in 1986. However, the great bulk of their funding is going into the AVLIS process which they call SILVA. Their objective is to either augment their capacity or replace their diffusion plants at the turn of the century.

Just recently the Japanese announced the formation of an industry-government panel to study the decision as to how they ought to proceed in enrichment, between centrifuges and lasers.

I point these things out because I think there are quite dramatic realizations around the world of the way the technology is changing, and to indicate that at least with the French we have a 5-year lead today. I hope after all we've spent in gaining that 5-year lead, we don't lose it.

Thank you very much.

[The prepared statement of Dr. Emmett follows:]

AVLIS Uranium Enrichment Program

Statement prepared for
Subcommittee on
Energy Research and Production
House Committee on Science and Technology

February 1985

University of California
Lawrence Livermore
National Laboratory

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by
John L. Emmett
Associate Director for Lasers
Lawrence Livermore National Laboratory

February 1985

Last year I testified before this Committee on the status and potential of the Atomic Vapor Laser Isotope Separation (AVLIS) Program. Since that time, nothing has occurred to modify those judgments regarding the Program, and so I would like first to review the points made last year.

- Production-scale demonstration of the AVLIS process can be achieved in 1987 and such a demonstration would substantiate the economics of the process. Based upon the fact that AVLIS shows the greatest potential for low cost separative work units (SWUs) in the 1990s, Lawrence Livermore National Laboratory (LLNL) and Union Carbide Corporation - Nuclear Division jointly recommended in January 1983 that such a demonstration be supported by DOE.

- I pointed out that production plant designs have been evaluated every year for many years and have continued to show SWU production costs of approximately $25/SWU with a range between $15/SWU and $35/SWU in constant dollars with a plant capital investment of approximately $100 million per million SWU/year installed. Continued technology improvements have allowed these projections to stay even or beat inflation and escalation.

- We prepared a simple financial analysis which showed that selection of the AVLIS process could improve the financial posture of the uranium enrichment enterprise, achieving both price reductions and increased return on investment.

- The plan to accelerate the selection between AVLIS and AGC was justified on the basis of cash flow problems within the DOE uranium enrichment enterprise. We supported this acceleration, but pointed out that a process selection prior to 1987 would be based on limited operations and economic demonstration by both Programs.

- I indicated that the schedule for achieving a partial demonstration of production-scale subsystems by March 1985, was indeed tight and the FY 85 funding was inadequate by about $25 million. Nevertheless, we committed to a best effort to achieve a partial demonstration of the process, adequate to permit an informed process selection aided by being able to front end load our spending during the first portion of the year.

I would like now to update this testimony and respond specifically to your request for comments on DOE's program plan and on minimum outyear expenditures for the AIS Program.

To refresh your memory, the AVLIS process concept is shown in Figure 1 illustrating the laser system and separator system concepts. A full-scale production prototype is currently under construction at Livermore in the facility shown in Figure 2, and Figure 3 shows a conceptual layout of the production scale equipment within this facility. Figure 4 shows construction progress on the uranium separator chamber as of late January. This facility was constructed on a fixed-price, performance contract by Chicago Bridge and Iron (CBI). Figure 5 shows installation of the vaporizer power supply which was constructed by Maxwell Laboratories Inc. (MLI) on a fixed-price, performance contract. Figure 6 shows an assembled copper vapor laser, and Figure 7 shows one corridor in the copper vapor laser facility, illustrating the partial installation as of late January. A large number of contractors around the country have supported the laser construction effort. We are about one month behind our schedule goals but still expect to achieve initial equipment operation in March. The most significant aspect of this construction effort is that we are within 10% of our original cost and schedule goals established last year. This small cost growth is largely due to the premium payments required to accelerate delivery for the March 1985 demonstration. We are very pleased with the results to date and feel even more confident that the original objective of full-scale production prototype operations can be initiated in 1987.

The specific demonstration schedules for March 1985, will utilize the partially completed laser system in the production prototype facility and the older, one-half scale uranium separator facility (Figure 8) located about 1 km distance from the production prototype facility. The laser light will be transmitted through an underground beam pipeline as shown in Figure 9. We are still trying to maintain the March date, and expect to achieve it if initial activation problems can be overcome. We have upgraded the demonstration from a single cell to a multi-cell demonstration in order to achieve the maximum amount of progress. When this effort is completed, it will further confirm the potential of the AVLIS process.

In addition, we are continuing our efforts to establish reliable operation of our liquid uranium processing in the separator system. This work is being conducted primarily by Martin Marietta Energy Systems at Oak Ridge where the Materials Handling Demonstration Module (MHDM), Figure 10, is carrying out extended operating cycles. To date, tests have been conducted up to about 25% of the production run times. If we can keep this effort going, it appears possible to extend the operating cycle to full economic production times within the next 18 months.

During the past year, we have worked with Martin Marietta Energy Systems, Bechtel National, Inc., Stone and Webster Engineering Company, and Westinghouse Electric Company to update our production plant designs, costs, and schedules. The results of these efforts have confirmed our earlier projections that a mature AVLIS production plant can operate in the 1990s, and can be constructed for a capital cost of approximately $100 million per 1 million SWU per year. When operating costs are included, we now project a probable cost of $25/SWU with a range of $15/SWU to $40/SWU. The characteristics of the most recent plant design are summarized in Figure 11.

The schedule of major activities and events to follow through on the AVLIS Program is shown in Figure 12. The funding requirements to meet this schedule are shown at the bottom of the figure. Based upon the work completed during the past year, we believe the schedule and cost uncertainties have narrowed somewhat. We have estimated that production prototypical operation can be achieved by the beginning of FY88 for approximately $375 million. Our uncertainty analysis indicates a range in schedule between 4Q87 and 3Q88 for a cost range between plus $75 million and minus $50 million. This milestone represents not only full production SWU rates but substantial completion of the reliability growth phase and initiation of the final verification of production reliability. Completion of this phase would allow a construction start on the AVLIS production plant with minimal technical risk of achieving the Program goals.

We have evaluated the financial impact of selecting AVLIS for further demonstration and deployment according to the schedule defined above. Figure 13 shows the current DOE forecast of prices through the year 2000 and, for comparison, the cost of sales is shown in the same figure. The "cost of sales" includes all costs (direct operating, depreciation, overhead, RD&D) except imputed interest. It is clear that recovery of government costs with interest cannot be achieved in the near-term, but our analysis shows that the price-cost differential shown here does allow full cost recovery with interest prior to the year 2000. The projected revenues and cash outlays associated with this plan are illustrated in Figure 14. The range in revenues corresponds to the range in price forecasts from the previous figure. The range in cash outlays results from alternatives in inventory management and uncertainties in RD&D costs, new AVLIS construction costs, and future operating costs. To deal with these uncertainties we have done a detailed evaluation of the AVLIS Program, and have assigned a potential for 20 percent increase or for 10 percent decrease in the cost numbers presented in Figure 12. These cost variations are over and above normal contingency already included. This figure clearly indicates AVLIS demonstration and deployment can be achieved with zero net appropriation.

With regard to DOE's plan for further demonstration and deployment of AVLIS, I don't believe it will be made clear to us until after the selection decision in May 1985. We prepared an updated proposal to DOE on January 15, 1985, and it was accepted by them as a reasonable planning basis, and the principal change in this plan from previous ones is a delay in plant construction start. In previous plans, plant construction was initiated after initial operation of the production prototype, whereas now plant construction is not initiated until one year of reliability and life testing of the production prototype. One year of reliability and life testing of the production prototype will define the operating costs and maintenance levels of the limited lifetime portion of the equipment. The most limited life component of AVLIS is the actual separator pod. In one year we will run each of three separate pods through ten complete plant operating cycles. This testing will define the SWU costs to the 90% confidence level. This very short test time required to fully define operating costs is one of the very attractive features of the AVLIS process.

Testing of limited life components for approximately their full economic lifetime before committing to plant construction or large volume procurements is of the utmost importance to ensure that a new technology is indeed economic. In that context, the economic validation of the Set V centrifuge cannot be conducted without running a quantity of rotors for a large fraction of the proposed five- to ten-year life on which the economics are predicated. Testing several hundred rotors for a year or two will determine reliability. However, only running a quantity of rotors to wear out end-of-life will define their operating costs.

The uranium enrichment enterprise has a very difficult financial situation where future discretionary income from enrichment revenues is limited and therefore future decisions on new production capacity must be relatively certain to avoid squandering these limited resources. We have attempted to respond to this situation in a recent proposal to carry out more testing prior to a plant construction start. If AVLIS is not selected for full scale demonstration in the near future, we will not be able to address production performance under production prototypic conditions, so that uncertainty would still remain after prolonged testing at the current scale. Nevertheless, some progress could be made at the current scale. With regard to your request for an "assessment of the minimum outyear expenditures for the AIS program, whether or not this technology is selected for eventual deployment," I interpret this to mean sustained process testing at the current scale of facilities. Such a testing program would allow us to keep the critical team together and make some progress in narrowing the performance uncertainties. The level of support to carry out this effort would be approximately $50 million per year over a two year time period. If this were strung out much beyond two years, very little new would be learned without scaling the facilities up to production prototypic conditions. For this reason, we continue to recommend that the facilities be brought to production prototypic scale as quickly as possible so that the AVLIS process performance can be demonstrated at production conditions.

I would like to thank this Committee for your continued support and for the opportunity to appear before you today.

Atomic vapor laser isotope separation – major systems

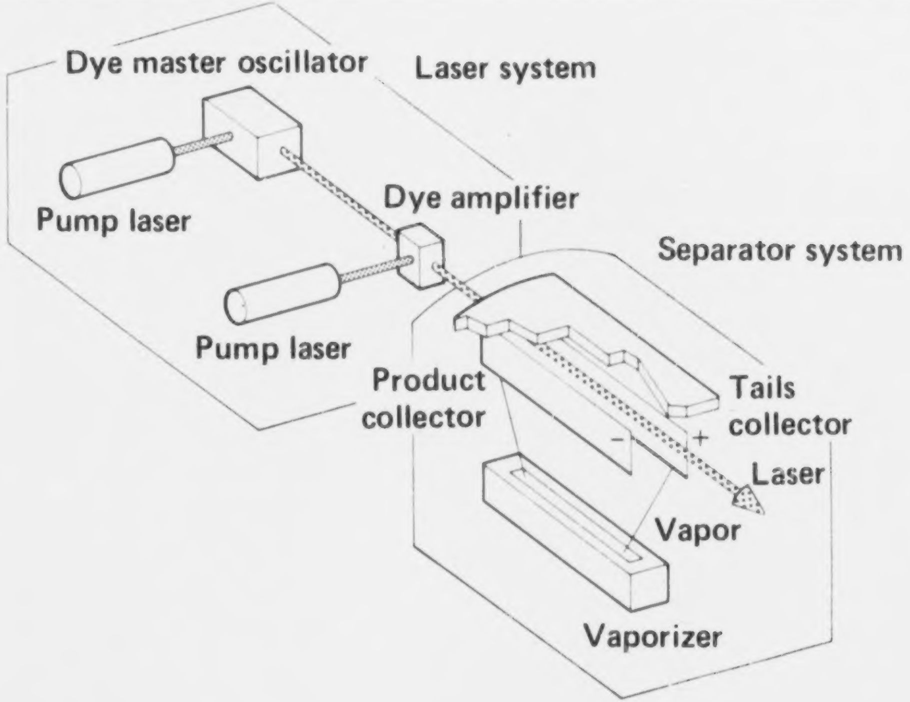
Dye master oscillator
Laser system
Pump laser
Dye amplifier
Separator system
Pump laser
Product collector
Tails collector
–
+
Laser
Vapor
Vaporizer

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Figure 1

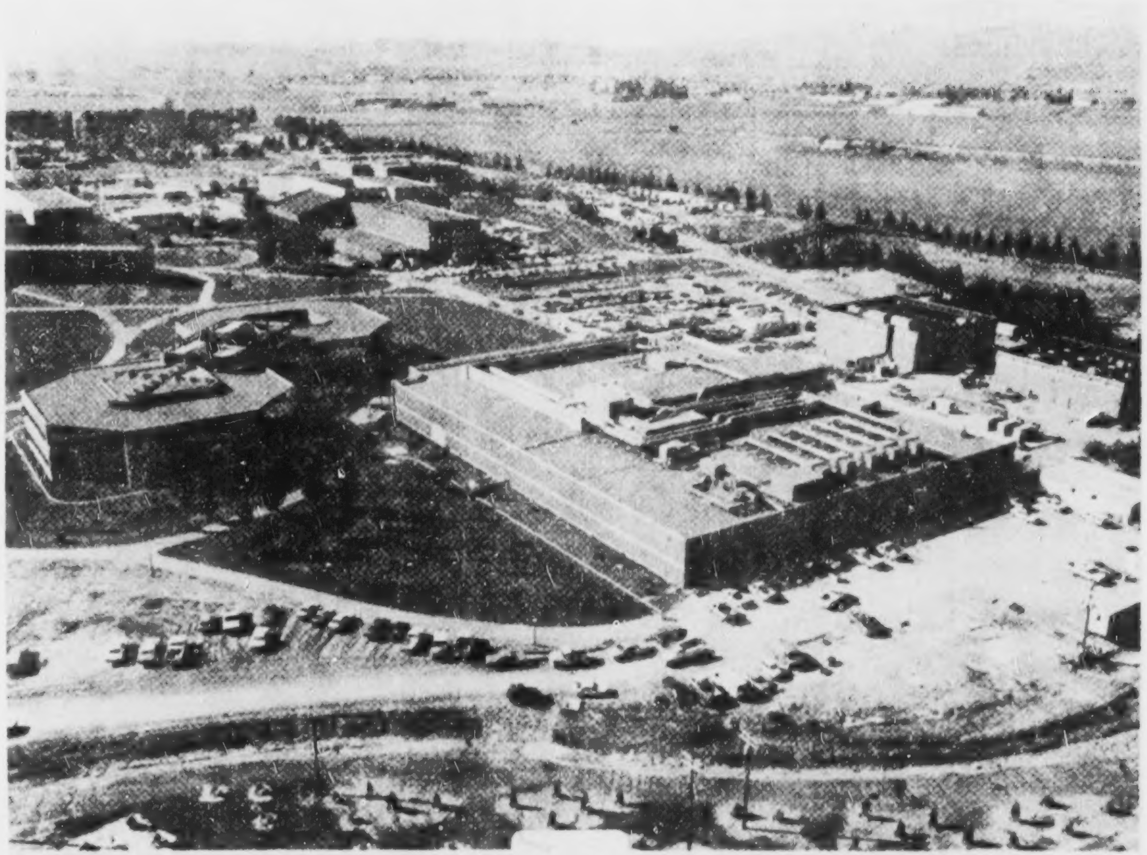


Figure 2

Production-scale AVLIS demonstration system

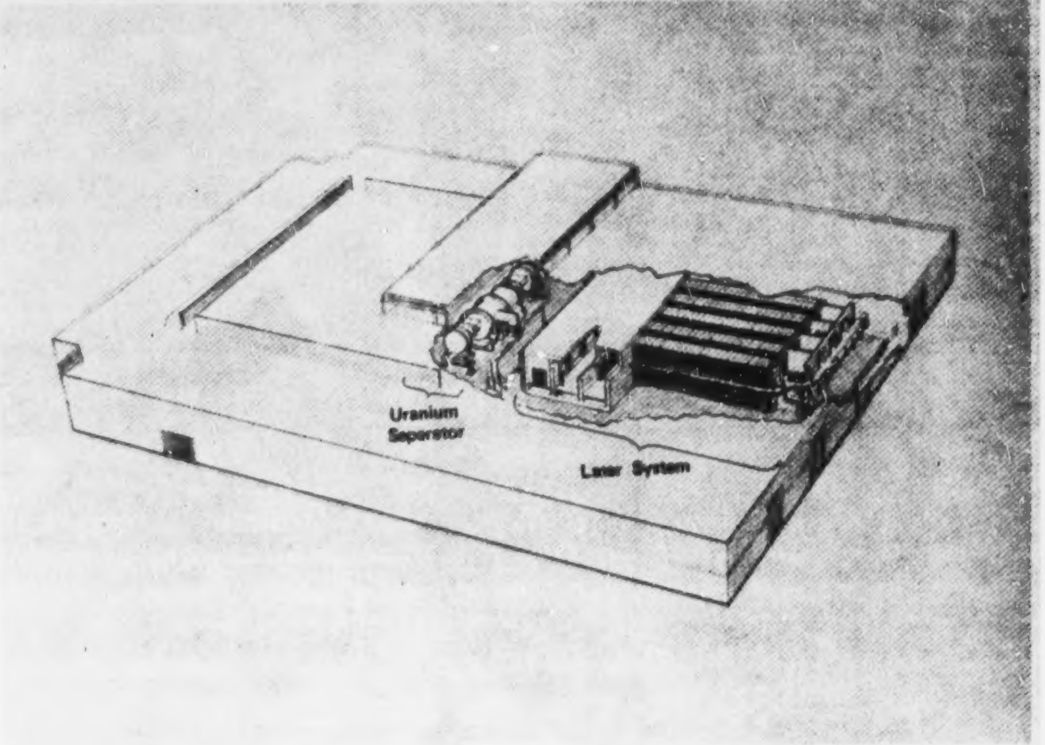

Uranium Separator
Laser System

Figure 3

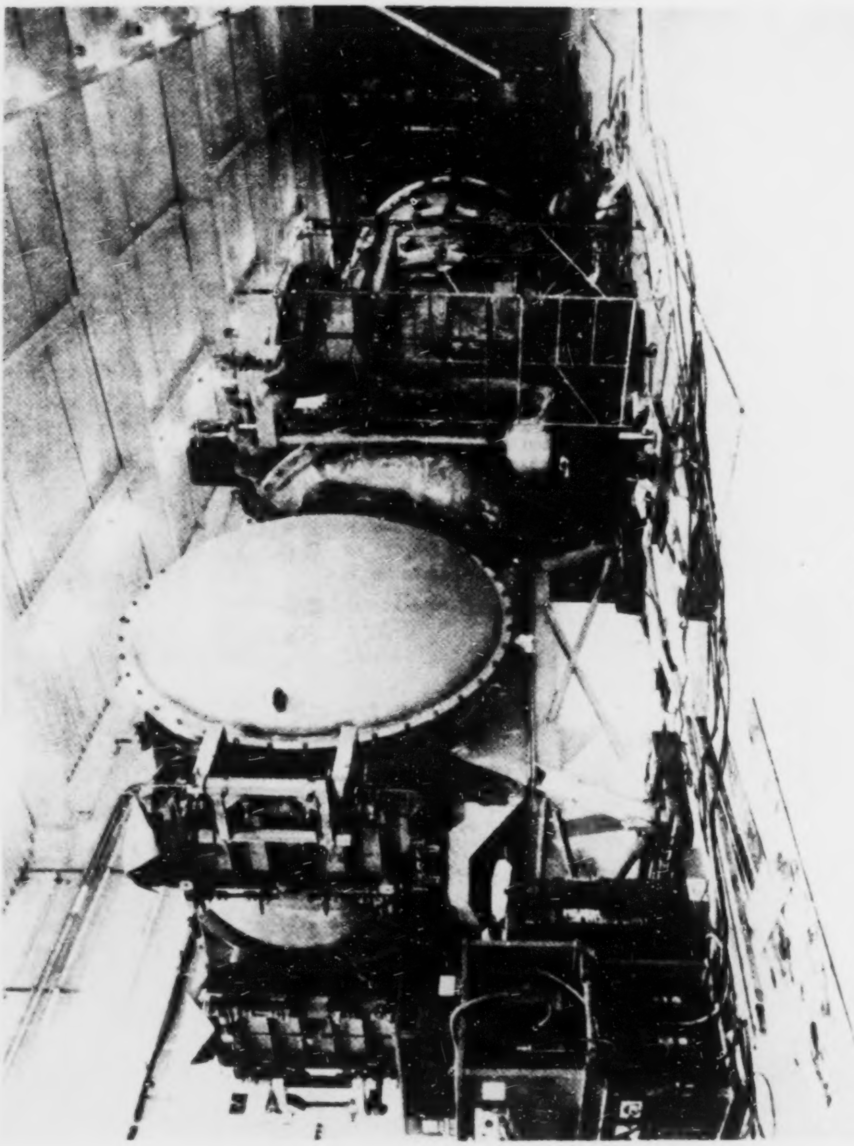


Figure 4

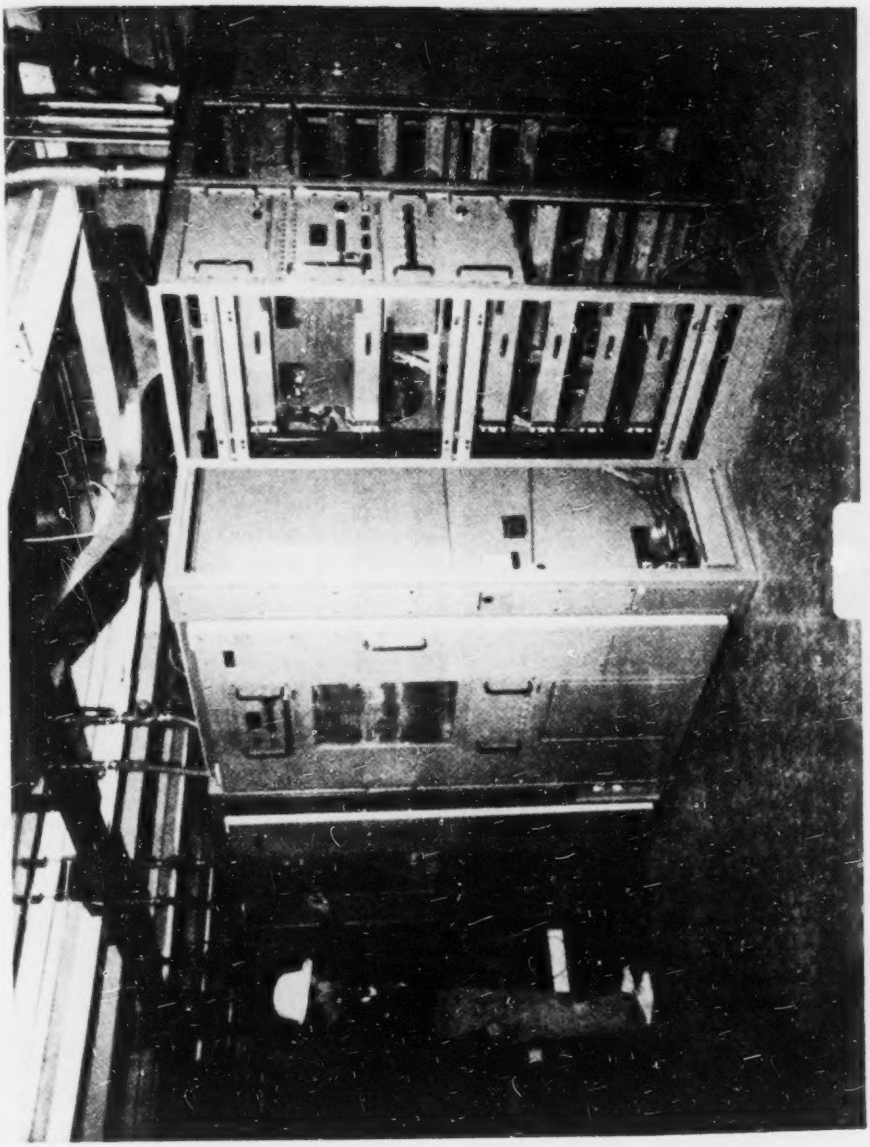


Figure 5

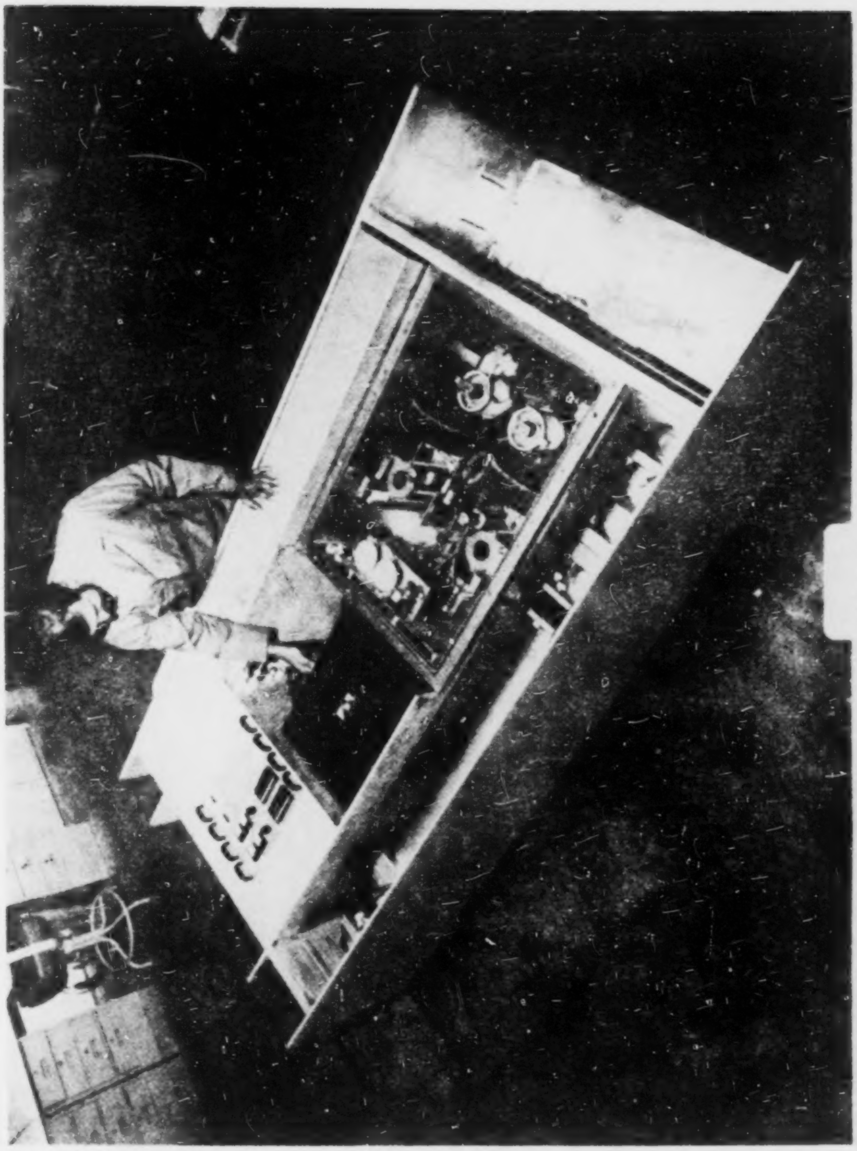


Figure 6

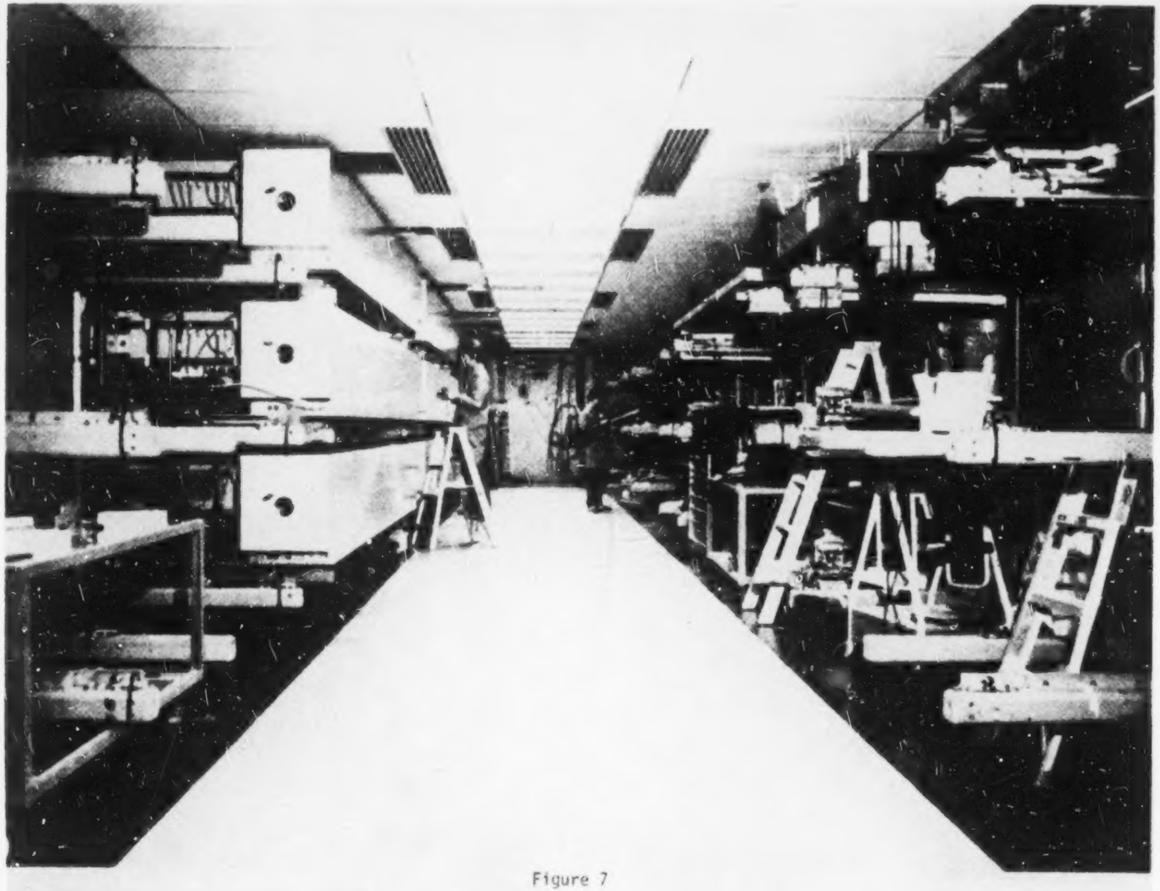


Figure 7

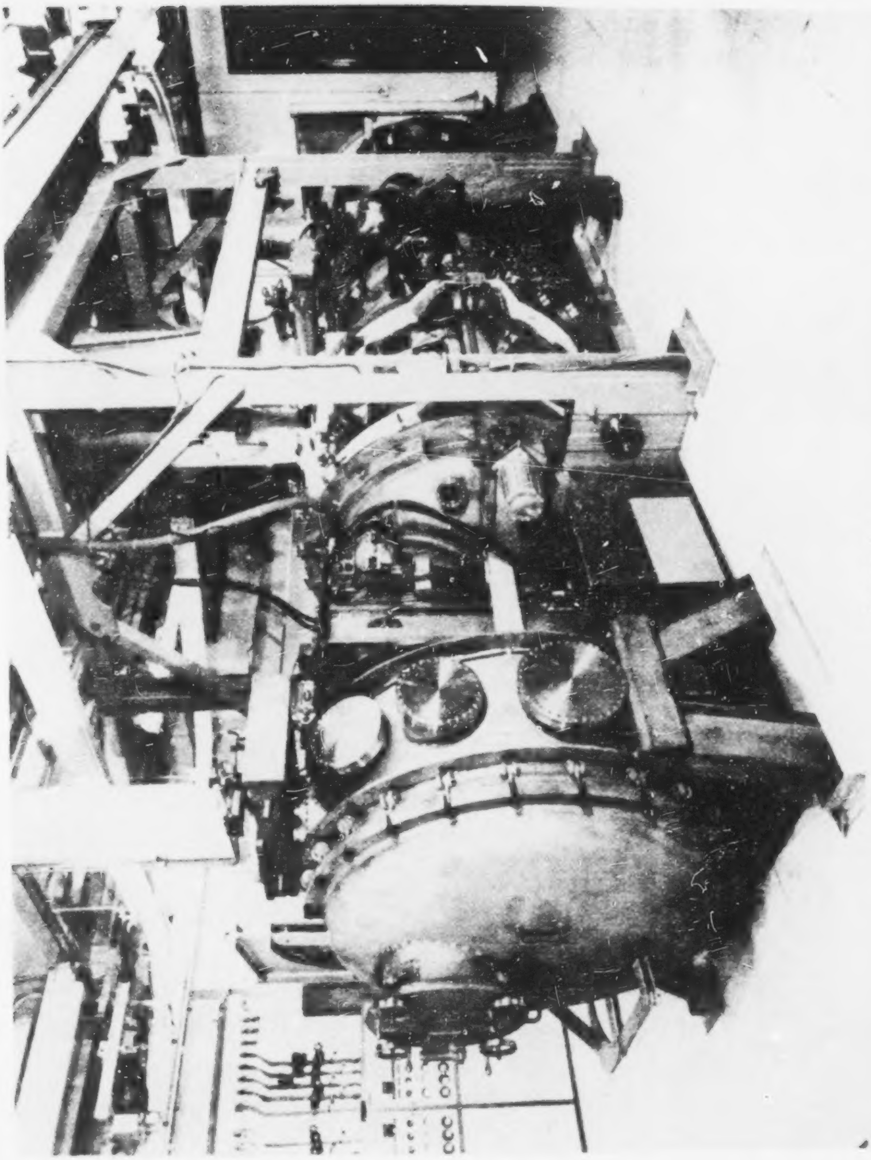


Figure 8

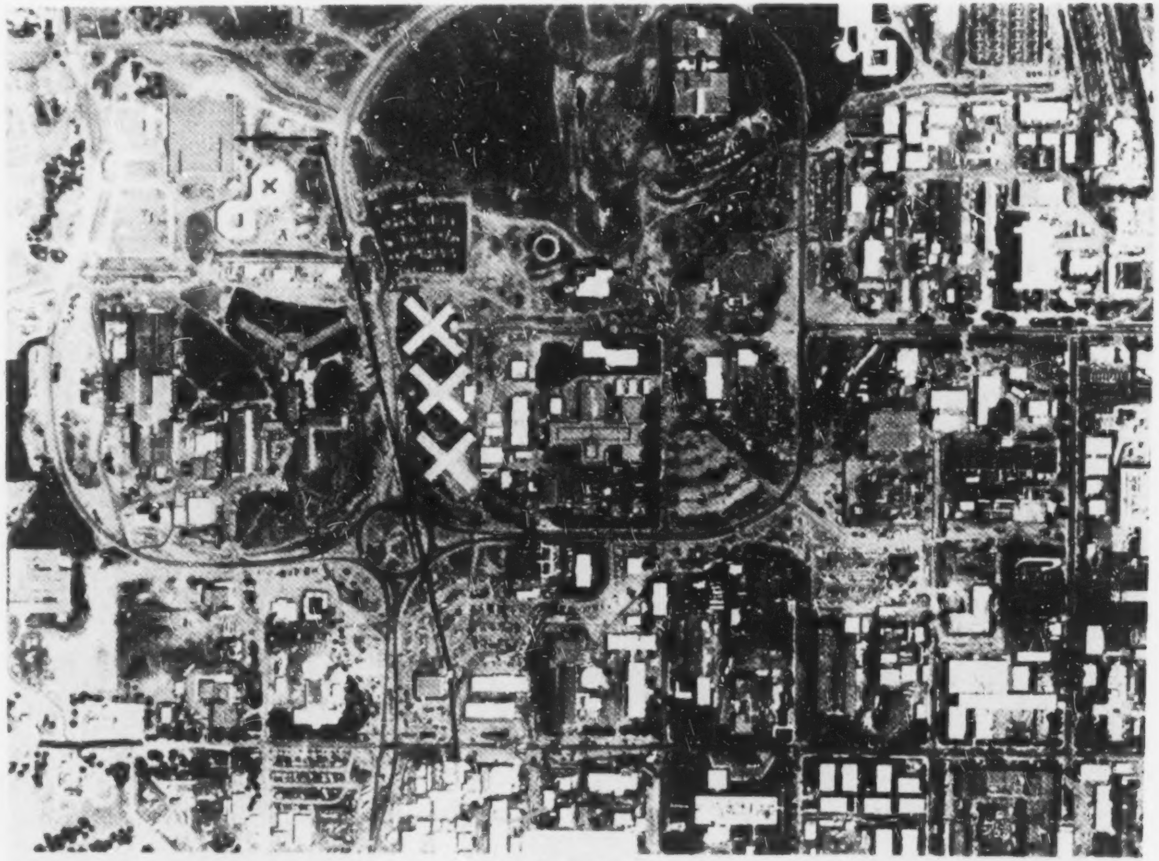


Figure 9

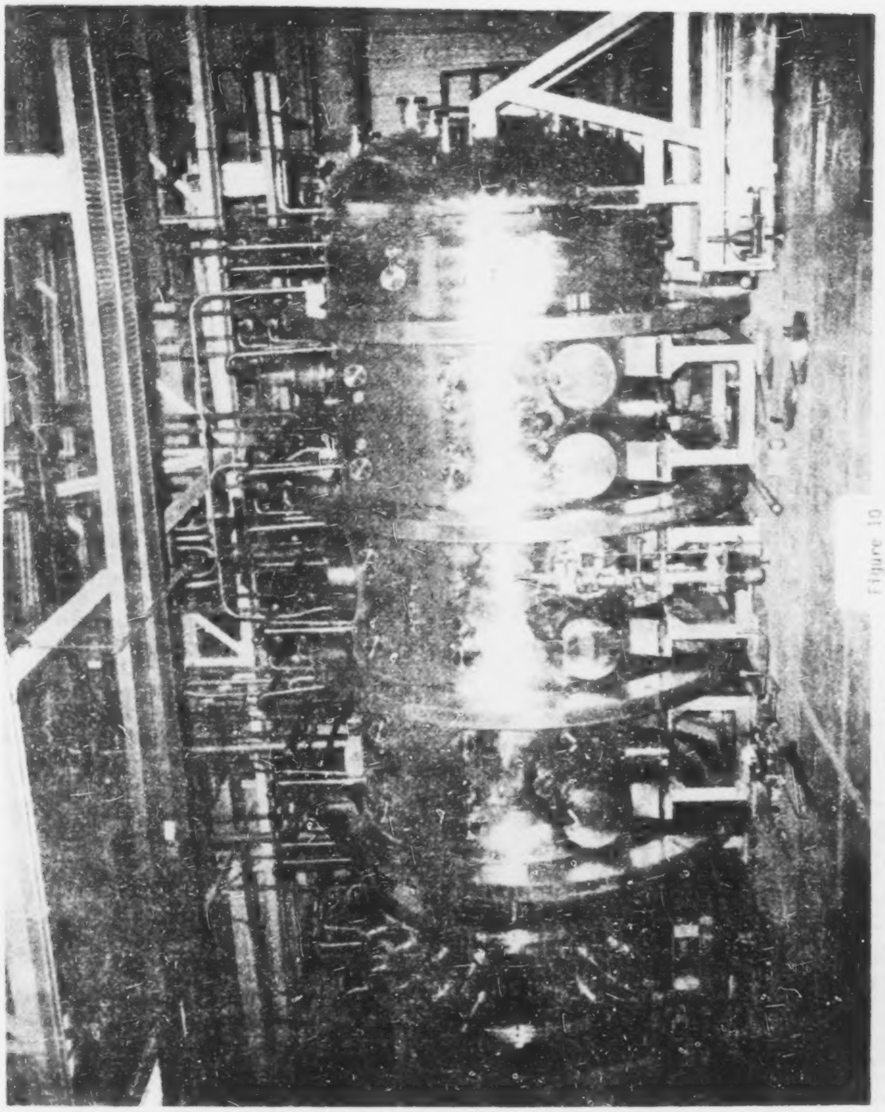


Figure 10

Summary of AVLIS plant *

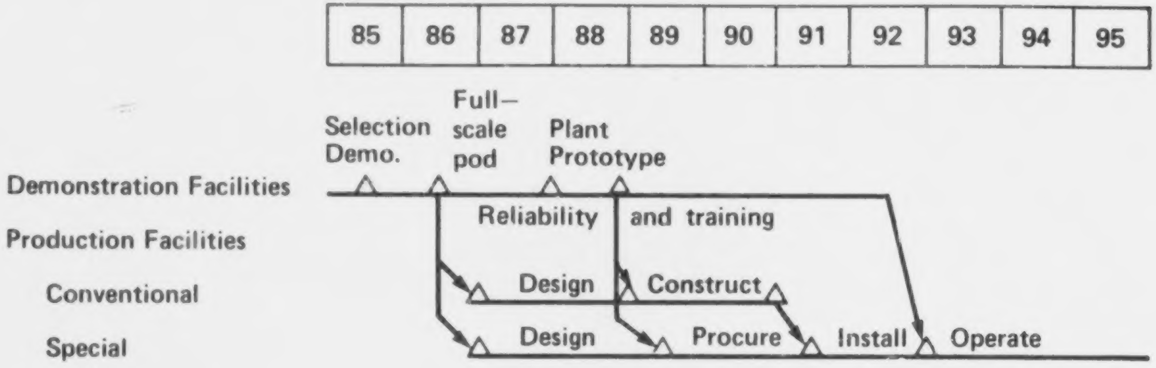
Production capacity	11.8 million SWU/y
Product (@ 3.2%)	2.4 million kg/y
Operating cost	$200 million/y
Capital cost	$1,200 million
Production cost	$25/SWU

*Based on design work performed by LLNL, Bechtel National, Inc., Stone and Webster Engineering Company

30-05-0285-0680

Figure 11

AVLIS Demonstration/Deployment Schedule and Costs


85
86
87
88
89
90
91
92
93
94
95
Selection Demo.
Full-scale pod
Plant Prototype
Demonstration Facilities
Reliability and training
Production Facilities
Conventional
Design
Construct
Special
Design
Procure
Install
Operate

Costs and Production	85	86	87	88	89	90	91	92	93	94	95
Demonstration	102	125	150	130	85	50	25	13			
Production Plant			5	30	140	200	250	300	200	132	
Production Operations						6	22	54	110	179	199
Product (MSWU)									2	9	12

(All FY86 $M except FY85)

Figure 12

Price and cost forecasts for GDP: AVLIS selection

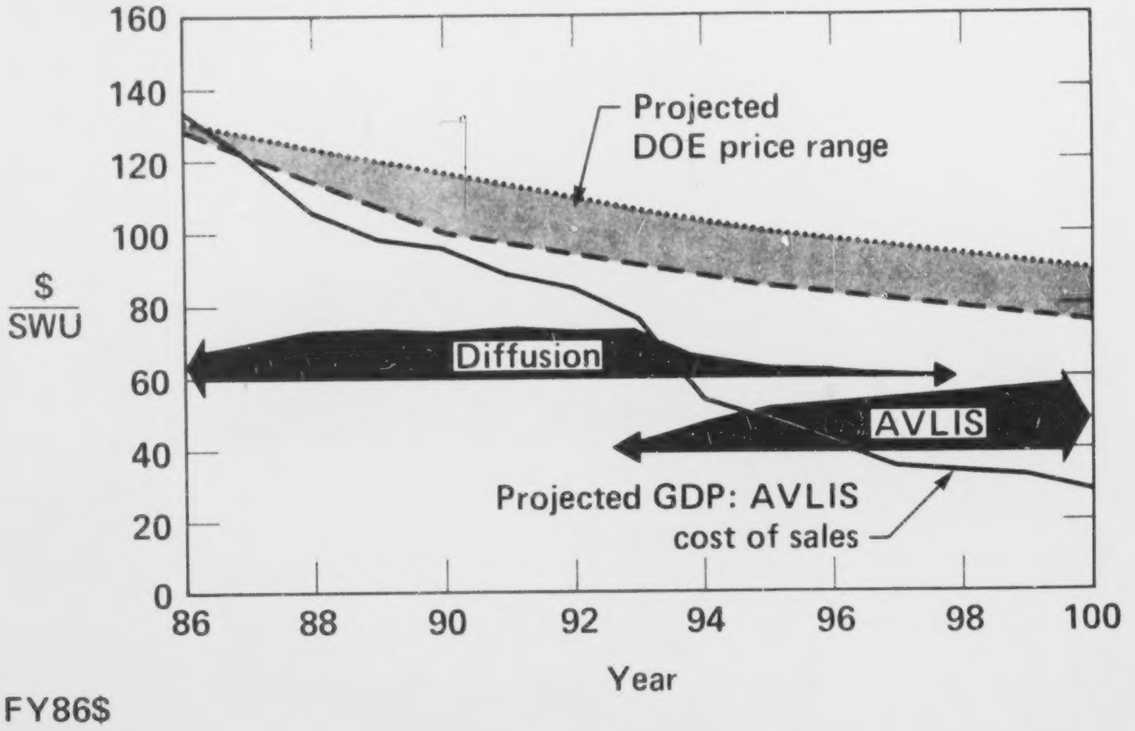


Figure 13

Revenue and cash outlay forecasts for GDP: AVLIS selection

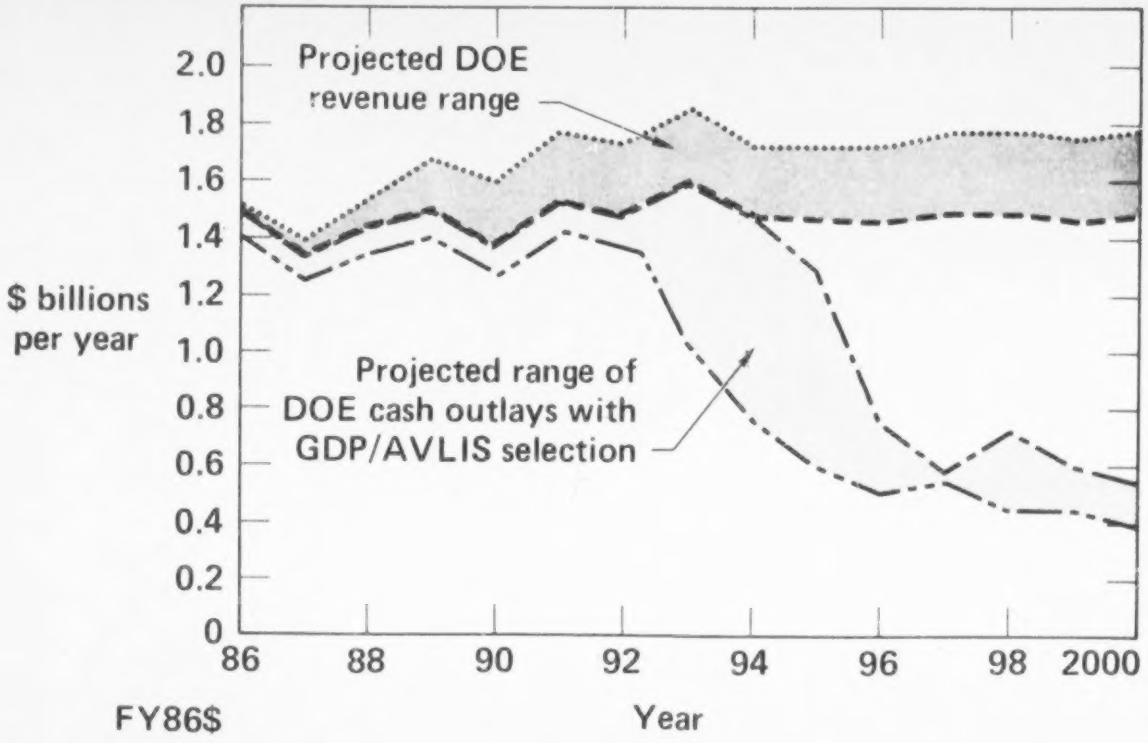


Figure 14

Mrs. LLOYD. Thank you very much, Dr. Emmett. I hope I can get out and visit your facilities this year. It's one of the things that I am looking forward to.

Have you run into any technological snags in the development of AVLIS that you think may increase the cost beyond the projected cost of up to $40 or $45 a SWU, or delay it from the achievable schedule that you gave us last year?

Dr. EMMETT. No, I think not. As a matter of fact, our experience all the way along in this program has been very uncharacteristic of a lot of programs I am familiar with. That is, in general, innovation has driven down our costs faster than technological cost growth has raised our costs. I think the most striking feature of the program is, our costs have been reviewed very aggressively on several occasions in the last few years and they continue to hold or go down.

No, we have not run into a technological issue that we think will raise costs.

Mrs. LLOYD. Well, isn't it true that technological uncertainty is translated to economic or cost uncertainty?

Dr. EMMETT. In the absence of innovation, ma'am, that's true. I think possibly what you're referring to is the Rand study which indicates that high technologies always overrun their costs very greatly. Having read that study to some degree, I profoundly disagree with the conclusion. The conclusion in that study is, it has something to do with the technology. My conclusion would be, it totally has to do with the way that the technology is managed and the development programs are managed. I think with competent management there is no reason to see any substantial cost growth whatsoever.

Mrs. LLOYD. Well, I disagreed with the Rand report on Clinch River, I think you vividly remember——

Dr. EMMETT. Yes, I think we both do.

Mrs. LLOYD. In terms of percentage completion toward the stage where a competent decision can be made on the best technology, how would you rate AVLIS and AGC?

Dr. EMMETT. Oh, I would say today, with my neutral hat on, they are very equivalent. That is, I would not make a decision to deploy either technology without a full-scale demonstration of the critical components run for their defined economic life. It is clear to me that the centrifuges will operate and produce separative work. There is no question about it. It is clear to me that AVLIS will work and produce separative work. We have demonstrated that, so there is no question of the technologies working.

The issue that remains before us is simply the cost. Cost is the only issue in isotopic separation. There is not a technical issue. I think that a full-scale demonstration in AVLIS under plant prototypic conditions is required to define that cost to the benefit of nontechnical decisionmakers. I think the equivalent full-scale demonstration of centrifuges running out a reasonable fraction of their economic life is, again, required for nontechnical decisionmakers to make a decision.

Mrs. LLOYD. Thank you very much, Dr. Emmett. We appreciate your testimony today.

Our next witness is Mr. George Jasny, who is vice president of energy and computing for Martin Marietta Energy Systems Group.

We are very happy to have you with us, also. I think that our staff told you that we were running on a 10-minute time schedule. Oh, you have 15 minutes. You're not on the panel. Pardon me. Your complete testimony will be included in the record, so you may proceed as you wish. Again, we're very happy to have you with us today.

STATEMENT OF GEORGE R. JASNY, VICE PRESIDENT, ENGINEERING AND COMPUTING, MARTIN MARIETTA ENERGY SYSTEMS GROUP, INC.

Mr. JASNY. Madam Chairman, I am pleased to be here today to give you Martin Marietta's views on the uranium enrichment program.

The people of Martin Marietta—until 10 months ago the people of Union Carbide—bring a special perspective to the uranium enrichment enterprise. For over 40 years they have served the U.S. Government by evaluating, developing, engineering, and operating uranium isotope separation processes. We have a broadly based and abiding interest in the continuing good health of the enrichment enterprise and the decisions which affect that good health.

From that vantage point, we see this enterprise, which is so important to our country strategically and economically, engaged in a struggle for survival. Its product is a commodity which must compete in the world market, where competition is increasingly based on price. There is worldwide overcapacity, caused by delays and cutbacks in nuclear plant construction. Our foreign competitors, particularly the French, aided by the strength of the dollar, are undercutting our price by about 30 percent.

The new utility services contract recently offered by DOE to its customers has firmed up the future demand for our enrichment services, but it confirmed reductions in that demand, particularly over the near term. It is obvious that to retain its dominant role in enrichment, the United States will have to meet at least two challenges: For the near term we must try to maintain our market share and do so within our revenues. For the long term we must position ourselves to achieve a price advantage over our competitors.

Given these challenges, the elements of a strategy for 1986 and the next few years are becoming increasingly clear: We must market aggressively, cut our costs and our prices, and continue to develop an advanced technology for the long term.

The United States was once the sole supplier of enriched uranium to the free world. This monopoly position led to a certain rigidity in attitude and contract terms which was, we have now learned, deeply resented by our customers. Our competitors took advantage of our mistakes. As the new utility services contract demonstrates, DOE has learned from them.

DOE has asked for our assistance in this area, and we have responded. This month some of our senior managers, including the president of Martin Marietta Corp., joined DOE officials in a marketing trip to Japan, South Korea, and Taiwan, where demand for enrichment services continues to grow. The services of Martin Marietta's Tokyo staff have been made available to support uranium marketing efforts in the Far East.

Finally, we have recently announced the establishment in Oak Ridge of an enrichment business services unit to be headed by one of our vice presidents. This new unit will assist DOE in program planning and evaluation and in marketing. Not only do we believe that marketing efforts will be an important effort in the survival of the enrichment enterprise, we are also willing to put our corporation's marketing know-how behind these efforts.

It takes less than a marketing genius to recognize that, given dependability of supply and contract flexibility, price is the ultimate marketing tool for commodity products. Quality is really not an issue here: A SWU is a SWU is a SWU. Price is important in two ways: It should be competitive but it should also be predictable.

The key factors behind DOE's success in retaining a large share of its contracts during the recent contract conversion were increased contract flexibility and the establishment of a price ceiling, coupled with the promise of future price reductions. In our view, it is important for DOE to start delivering on its promise in 1986. Prices should be cut by a reasonable amount, $5 to $10 per SWU, and affordable price cuts should continue in subsequent years. We can think of no better signal to DOE's utility customers that the United States is serious about competing for their business. In addition, we concur with DOE's plans to institute as soon as possible an incentive pricing structure designed to capture the portion of the utilities enrichment needs which was not purchased from DOE under the new utilities service contract.

Within the constraints of limited revenues, price cuts can only be made possible by real cost reductions. This will be particularly important over the next 5 years when demand will be low and production needs will be even lower because part of the demand will be met by drawing down the U.S. stockpile.

For at least the next 8 to 10 years, the gaseous diffusion complex will be the main source of enriched uranium production in the United States. Its operating cost, including currently a very large demand charge for electricity, represents the lion's share of the annual cost of the uranium enriching enterprise. We are aggressively pursuing various avenues of cost reduction in the gaseous diffusion plants we operate, including manpower reductions and more efficient utilization of electricity.

Our most recent cost-cutting initiative, which may be our most important, is directed at cutting the cost of the electricity we purchase. Given the fact that demand charges are essentially fixed, the energy fraction of our electricity costs is a critical cost element representing approximately 80 percent of the marginal cost of enriching uranium by the gaseous diffusion process. We are attacking the cost of that energy fraction by a fundamental change in our operating mode. Simply put, we have offered to become part of the spinning reserve of our electricity suppliers, principally TVA but also OVEC and EEI, and of course in this effort Goodyear Atomic Corp. is also involved.

We have offered to take a large fraction of our electricity needs in the form of interruptible power, thereby enabling these utilities to reduce peak demand on their system and avoid the use of costly peak shaving techniques such as pumped storage or gas turbines. When most ratepayers need their electricity, we reduce our consumption, and vice versa. The overall cost is less and everybody benefits, including the ratepayers.

We are in the early phases of a 9-month experiment with TVA in the use of interruptible power. The results so far are very encouraging. We have experienced no real operating difficulties. The average price we have paid for interruptible electricity has been $18 per megawatt hour, versus $25 for firm electricity. Last weekend we paid $15 per megawatt hour. We believe that as we——

Mrs. LLOYD. Pardon me.

Mr. JASNY. Yes, ma'am?

Mrs. LLOYD. Would you repeat that cost again?

Mr. JASNY. So far in the beginning of this experiment we have been paying $18 per megawatt-hour for our electricity, whereas our firm price is $25. The price changes very frequently.

Mrs. LLOYD. I was noticing in your statement you said that "last week we paid $17."

Mr. JASNY. Yes, ma'am. That was two weekends ago, and this last weekend we dropped to $15.

Mrs. LLOYD. Good. I hope you have a better week next week. [Laughter.]

Mr. JASNY. Yes, we do, too.

We believe that as we and TVA develop and realize the full benefit of this approach, even lower rates and, equally important, large quantities of power will be made available. We are encouraged by TVA's cooperation and their willingness to explore new arrangements with us. Clearly this is an experiment which should be allowed to run its course.

Mrs. LLOYD. Well, are you satisfied with the options that TVA is giving you now?

Mr. JASNY. We see a major change in their attitude. Both we and they realize that, as in any experiment, we must try a number of new approaches. We are trying several things on a short-term basis. We need to explore the possibility of seasonal power which would also be interruptible, which would give us much larger blocks of power. So far, I must say that in terms of cooperation and willingness to try things, we are satisfied with TVA, but obviously this is just the beginning.

Mrs. LLOYD. But you feel that they will work with you to make the power competitive?

Mr. JASNY. Yes, ma'am.

Mrs. LLOYD. That's very good news. Thank you.

Mr. JASNY. Yes, indeed.

To take advantage of this interruptible power, we are essentially converting unused production capacity in the three gaseous diffusion plants into storage capacity where we can put gas when we don't have the power to pump it through the converters, and it should be understood that we wouldn't have been able to do this were it not for the fact that we are now operating at low production throughput. We have spare equipment, and what we are trying to do in essence is to trade unused capacity for cheap power.

As long as that results in low-cost separative work and as long as we can meet our demand, clearly this is the right thing to do.

I would like to turn now to two other matters affecting the cost of the enrichment enterprise. Each involves some difficult decisions, but decisions which we believe must be made. The first has to do with choosing the advanced enrichment technology which will provide our competitive edge in the 1990's and beyond. That choice is scheduled for May 1985, and we urge that this choice not be deferred. By "choice" we mean the selection of one technology to be carried through full demonstration prior to deployment, with the technology not selected to be funded at a lesser level as a backup until the reliability of the chosen technology is demonstrated, a period of approximately 2 years.

We urge that the choice not be deferred for several reasons. Given the enrichment revenues picture, the cost of fully demonstrating both technologies is incompatible with cutting the price of our SWU's. It's probably incompatible with maintaining the price of our SWU's at the present level. Both technology teams have demonstrated such technical competence that either technology can, in our opinion—and I concur with Dr. Emmett in that regard—either technology can be brought to technical fruition, but that is not the primary issue. The decision must be made on the basis of which technology is likely to be the cheapest when put in production in the mid-1990's.

We believe that by May DOE will have in hand adequate technical and projected cost data to make an informed choice. Of course, there will still be uncertainties associated with the cost of the SWU's from either technology, but unfortunately these uncertainties will not be significantly reduced until the completion of reliability demonstration in 1988. A few months' delay in the decision would not help very much.

There are related reasons for making the decision. The peer review process, while necessary, is a heavy, expensive burden on both technology teams. The combatants in this fierce competition deserve a decision so they can rearrange their professional lives. DOE needs to show our customers and competitors alike—who are, I'm sure, watching with great interest—that the United States is committed to the aggressive pursuit of the world's cheapest enrichment technology.

The last matter I'll discuss has to do with the GCEP project. This project was authorized in 1977 as an addition to the U.S. enrichment capacity so that DOE could reopen its order books. With the advent of the Advanced Gas Centrifuge Program, a number of important elements of the development and demonstration program will be funded under GCEP and are scheduled to be carried out in GCEP facilities. These elements must be protected.

However, it is our view that all GCEP project activities which are not necessary to support the planned development and reliability testing of the advanced gas centrifuge should be brought to an orderly standstill as soon as possible. The intent of this recommendation is to defer those expenditures which can be deferred and assign the funds to more immediate priorities, such as the support of advanced technology development and price reductions.

GCEP has been a shining example of good engineering and management ever since its inception, and many of our best people have worked diligently to meet all of its milestones within predicted costs. So it is with considerable regret that we make this recommendation, but business conditions have changed; and despite some very imaginative realignment of the size and projected scope of GCEP, we are forced to conclude that deferring the capacity-related portion of GCEP while preserving its AGC-related components is the right thing to do.

In summary, Madam Chairman, Martin Marietta is committed to the support of a strong marketing program including price cuts and to the reduction of gaseous diffusion costs through the use of interruptible power. We believe that the advanced technology decision should take place this spring, as should the decision to defer GCEP construction project activities not related to advanced technology demonstration. These actions would, in our judgment, allow the program to support its priority objectives while living within its revenues.

Madam Chairman, this completes my testimony. I appreciate this opportunity to present my company's views. I will try to answer any questions you may have for me.

[The prepared statement of Mr. Jasny follows:]

STATEMENT OF
GEORGE R. JASNY
VICE PRESIDENT, ENGINEERING AND COMPUTING
MARTIN MARIETTA ENERGY SYSTEMS, INC.

BEFORE THE
COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION
U.S. HOUSE OF REPRESENTATIVES
FEBRUARY 28, 1985

Madam Chairman and Members of the Subcommittee, I am pleased to be here today to give you Martin Marietta's views on the uranium enrichment program. I will discuss what we consider appropriate elements of a strategy for the balance of the 80s with particular emphasis on the FY 86 program.

The people of Martin Marietta bring a special perspective to the enrichment enterprise. Our people in Oak Ridge built and operated the first three production enrichment plants in the world. They have played a major role in improving the economics of uranium enrichment, by two orders of magnitude. They currently operate two of the three gaseous diffusion plants in the United States. They started work on the gas centrifuge twenty-five years ago and maintain a key role in advanced gas centrifuge development. They have also assumed a major role in the development of the competing advanced technology—the Atomic Vapor Laser Isotope Separation Process. For over forty years they have served the US Government by evaluating, developing, engineering, and operating Uranium Isotope Separation processes. About 4,500 of our people are currently engaged in these activities. We have a broadly based and abiding interest in the continuing good health of the overall US enrichment enterprise and in the decisions which affect that good health.

From that vantage point, we see this enterprise, which is so important to our country, strategically and economically, engaged in a struggle for survival. Its product is a commodity which must compete in the world market where competition is increasingly based on price. There is worldwide overcapacity caused by delays and cutbacks in nuclear power plant construction. Our foreign competitors, particularly the French, aided by the strength of the dollar are undercutting our price by about 30%. The new Utility Services contract recently offered by DOE to its customers has firmed up the future demand for our enrichment services, but at the cost of losing some of that demand, particularly over the near term. It is obvious that to retain its dominant role in enrichment, the US will have to meet at least two challenges: For the near term we must try to maintain our market share and do so within our revenues; for the long term we must position ourselves to achieve a price advantage over our competitors. Given these challenges, the elements of a strategy for 1986 and the next few years are becoming increasingly clear: We must market aggressively, cut our costs and our prices, and continue to develop an advanced technology for the longer term.

The United States was once the sole supplier of enriched uranium to the free world. This monopoly position led to a certain rigidity in attitude and contract terms which was, we have now learned, deeply resented by our customers. Our competitors took advantage of our mistakes. As the new Utility Services contract demonstrates, DOE has learned from them. DOE has asked for our assistance in this area, and we have responded. This month some of our senior managers, including the president of Martin Marietta Corporation, joined DOE officials in a marketing trip to Japan, South Korea, and Taiwan where demand for enrichment services continues to grow.

The services of Martin Marietta's Tokyo staff have been made available to support uranium marketing efforts in the Far East. Finally, we have recently announced the establishment in Oak Ridge of an Enrichment Business Services unit to be headed by one of our vice presidents. This new unit will assist DOE in program planning and evaluation and in marketing. Not only do we believe that marketing efforts will be an important element in the survival of the enrichment enterprise, we are also willing to put our corporation's marketing know-how behind these efforts. We are confident that the results will be positive.

It takes less than a marketing genius to recognize that, given dependability of supply and contract flexibility, price is the ultimate marketing tool for commodity products. Quality is really not an issue here: A SWU is a SWU is a SWU. Price is important in two ways: It should be competitive, but it should also be predictable. The key factors behind DOE's success in retaining a large share of its contracts during the recent contract conversion were increased contract flexibility and the establishment of a price ceiling coupled with the promise of future price reductions. In our view, it is important for DOE to start delivering on its promise in 1986. Prices should be cut by a reasonable amount, $5 to $10 per SWU, and affordable price cuts should continue in subsequent years. We can think of no better signal to DOE's utility customers that the US is serious about competing for their business. In addition, we concur with DOE's plans to institute as soon as possible an incentive pricing structure designed to capture the portion of the Utilities enrichment needs which was not purchased from DOE under the new Utility Services contract.

Within the constraints of limited revenues, price cuts can only be made possible by real cost reductions. This will be particularly important over the next five years when demand will be low and production needs will be even lower because part of the demand will be met by drawing down the US stockpile.

For at least the next eight to ten years, the gaseous diffusion complex will be the main source of enriched uranium production in the US. Its operating cost, including currently a very large demand charge for electricity, represents the lion's share of the annual cost of the uranium enrichment enterprise. We are aggressively pursuing various avenues of cost reduction in the gaseous diffusion plants we operate including manpower reductions and more efficient utilization of electricity. These efforts have resulted in offsetting the cost of inflation in our non-electricity costs and in annual productivity increases of 1%/year over the past four years. We expect to achieve similar annual gains in the next two or three years. We have also recommended deferral of capital expenditures except for those related to environmental or safety improvements.

Our most recent cost cutting initiative, which may be our most important, is directed at cutting the cost of the electricity we purchase. Given the fact that demand charges are essentially fixed, the energy fraction of our electricity costs is the critical cost element, representing approximately 80% of the marginal cost of enriching uranium by the gaseous diffusion process. We are attacking the cost of that energy fraction by a fundamental change in our operating mode. Simply put, we have offered to become part of the spinning reserve of our electricity suppliers, principally TVA, but also OVEC and EEI, by taking a large fraction of our electricity needs in the form of interruptible power, thereby enabling them to reduce peak demand on their system and avoid the use of costly peak shaving techniques such as pumped storage or gas turbines. When most rate payers need their electricity we reduce our consumption and vice versa. The overall cost is less and everybody benefits. We are in the early phases of a nine-month experiment with TVA in the use of interruptible power. The results so far are very encouraging: We have experienced no real operating difficulties, the average price we have paid for interruptible electricity has been $18/MWhr versus $25/MWhr for firm electricity (last week end we paid 1\overset{5}{7}$), and we believe that as we and the TVA develop and realize the full benefit of this approach, even lower rates and larger quantities will be forthcoming. We are encouraged by TVA's cooperation and willingness to explore new arrangements for power delivery. Clearly this is an experiment which must be allowed to run its course.

You may well ask what has changed to make this use of interruptible power possible. Availability of that type of power for one thing, and we believe that availability will grow as TVA places additional nuclear units in service. On our side we have made changes to equipment and operating procedures to enable us to operate at lower power levels than was previously possible. We are essentially converting unused production capacity in the three gaseous diffusion plants into storage capacity for use during periods of power interruption. We would have been unable to do this were it not for low requirements for production now and over the next few years. As long as trading unused capacity for cheap power results in low cost separative work and production needs can be met it is the right thing to do especially since it has some corollary advantages such as preserving flexibility of response.

Let me turn now to two other matters affecting the cost of the enrichment enterprise. Each involves some difficult decisions, but decisions which we believe must be made. The first has to do with choosing the advanced enrichment technology which will provide our competitive edge in the 1990s and beyond. That choice is scheduled for May 1985, and we urge that this choice not be deferred. By choice, we mean the selection of one technology to be carried through full demonstration prior to deployment with the technology not selected to be funded at a lesser level as a back-up until the reliability of the chosen technology is demonstrated, a period of approximately two years. We urge that the choice not be deferred for several reasons: Given the enrichment revenues picture, the cost of fully demonstrating both technologies is incompatible with cutting the price of our SWUs. Both technology teams have demonstrated such technical competence that either technology can, in our opinion, be brought to technical fruition, but that is not the primary issue. The decision must be made on the basis of which technology is likely to be the cheapest when put in production in the mid 1990s. We believe that by May DOE will have in hand adequate technical and projected cost data to make an informed choice. Of course, there will still be uncertainties associated with the cost of SWU's from either technology, but these uncertainties will not be significantly reduced until the completion of reliability demonstration in late 1987 or early 1988. A few months' delay in the decision would not help very much. There are also related reasons: The combatants in this fierce competition deserve a decision so they can rearrange their professional lives; DOE needs to show our customers and competitors alike, who are watching with great interest, that the US is committed to the aggressive pursuit of the world's cheapest enrichment technology.

The last matter I will discuss has to do with the GCEP project. This project was authorized in 1977 as an addition to US enriching capacity so DOE could reopen its order books. With the advent of the Advanced Gas Centrifuge Program, a number of important elements of the development and demonstration program are being funded under GCEP and are scheduled to be carried out in GCEP facilities. These elements must be protected. However, it is our view that all GCEP project activities which are not necessary to support the planned development and reliability testing of the advanced gas centrifuge should be brought to an orderly standstill as soon as possible. The intent of this recommendation is to defer those expenditures which can be deferred and assign the funds to more immediate priorities such as the support of advanced technology development and price reductions. GCEP has been a shining example of good engineering and management ever since its inception with many of our best people working diligently to meet all of its milestones within predicted costs. So, it is with considerable regret that we make this recommendation, but business conditions have changed; and we are forced to conclude that deferring the capacity-related portion of GCEP while preserving its AGC-related elements is the right thing to do.

In summary, Martin Marietta is committed to the support of a strong marketing program including price cuts and to the reduction of gaseous diffusion costs through the use of interruptible power. We believe that the advanced technology decision should take place this spring as should the decision to stop GCEP construction project activities not related to advanced technology demonstration. These actions would, in our judgment, allow the program to support its priority objectives while living within its revenues.

Madam Chairman, this completes my testimony. I appreciate this opportunity to present my company's views, and I will try to answer any questions you or other members of the Subcommittee may have.

Mrs. LLOYD. I want Dr. Emmett to come back to witness stand. I have a joint question that I overlooked, I would like for both of you to answer. But before I ask both of you the question, I would like to ask Mr. Jasny, what should be the funding level in 1986, fiscal year 1986, for the losing technology?

Mr. JASNY. As you know, both the——

Mrs. LLOYD. As you know, this committee gave a directive to DOE to continue the funding.

Mr. JASNY. Both technology teams have been concentrating on their win strategy, and so the requirements need to be refined. However, it's our best judgment at this time that somewhere between $25 and $50 million, probably nearer the higher level, would be required by the losing technology to make a meaningful backup contribution.

Mrs. LLOYD. Well, $25 to $50 million, that's a pretty good spread. Are you leaning more toward $50 million?

Mr. JASNY. I'm leaning more toward the upper end of the range, yes, ma'am.

Mrs. LLOYD. For the fiscal year 1986?

Mr. JASNY. Yes.

Mrs. LLOYD. That is fairly close to the agreement that this committee did have with Secretary Hodel.

For both of you, what would be the impact on the present level of staff in the AVLIS Program between April 1 and May 15 if no additional funds are reprogrammed by April 1? I hope that you will indicate which of the affected staff at Livermore for you and Martin Marietta are the contractor personnel and which tasks they are presently carrying out. Who is this going to affect? What work are they doing that will be affected?

Also, I would like for you delineate which AVLIS activities could be carried out by this staff in this 6-week period if additional funds are reprogrammed by April 1. Now we need to know what minimum level of reprogrammed fundings are required to sustain the momentum of AVLIS development by retention of all the staff people through May 15—from May 15, rather, until the end of the fiscal year 1985 budget cycle, consistent with the choice of AVLIS as the selected technology.

Dr. EMMETT. Yes; let me take a cut at that first for both Livermore and Martin Marietta.

If I could have the first viewgraph, this shows the manpower levels that are currently and projected forward in the program. The blue on this chart is the Lawrence Livermore Laboratory; the red on this chart is Martin Marietta Energy Systems in Oak Ridge; and the yellow on this chart is our supporting contractors, who are Bechtel, Kaiser Engineering, Stone and Webster, and Bendix Field Operations.

Now, as you see, at the end of March we have to rapidly drop the program level in essentially a 2-month period of time to one-third the current operating level. Now if we were just going to carry that program level, say represented by the bar in March or the bar in February, out to the end of May, that would require $6.5 million jointly between us and Martin Marietta.

Now the real problem that we have is not just that. The real problem is, we really have no way of effecting that rapid a dropoff, whether or not that dropoff has to start in April or whether that dropoff starts in June. You know, Madam Chairman, you asked me last year when we committed to trying to do this demonstration, whether or not we had sufficient resources to carry through this demonstration. I said no, we did not; we were $25 million short.

Let me show you the next viewgraph. The next viewgraph shows what would be our situation with the contractors, with Martin Marietta, with ourselves at Livermore, if the additional $25 million had been put into the AVLIS Program, in that we would be able to carry our basic core level of effort and our key staff people in all organizations through a decision, through selling that decision on the Hill, and through a decision as to how the fiscal year 1986 budgets were going to be disbursed.

At Livermore we are in a situation where we have no way of dumping large quantities of people in short periods of time without just a direct RIF. That is, we have no other programs midway through the year that can absorb a few hundred people. I would like George to speak to that with regard to the Martin Marietta situation but that is our situation.

Mrs. LLOYD. Can you identify the workload that would be excluded. That's what I was wondering.

Dr. EMMETT. Yes; we are facing—well, Roger Batzel, the director of the laboratory——

Mrs. LLOYD. Delineate the activities that could be carried out.

Dr. EMMETT. Yes; we have to make the following decision at the end of next week, and that is whether to shut down the program irrevocably after the first week of April. We think we can make one try at an isotope separation run under the current budget.

What we would do, what the staff of Martin Marietta and Livermore and our contractors would do if we ran through May, is that we would be allowed to get several additional runs, isotopic separation runs, on the full system, and that would much enhance the confidence we would have on the basic data for the decision. We will only get, under the current budget situation, one chance to try it if everything works, and maybe zero if everything doesn't work the first time.

Mrs. LLOYD. George, would you like to respond?

Mr. JASNY. Yes, ma'am. First, let me say the numbers of people I am speaking about are consistent, within very few, with John Emstop GCEP construction project activities not related to advanced technology demonstration. These actions would, in our judgment, allow the program to support its priority objectives while living within its revenues.

Madam Chairman, this completes my testimony. I appreciate this opportunity to present my company's views, and I will try to answer any questions you or other members of the Subcommittee may have.

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Mr. JASNY. As you know, both the——

Mrs. LLOYD. As you know, this committee gave a directive to DOE to continue the funding.

Mr. JASNY. Both technology teams have been concentrating on their win strategy, and so the requirements need to be refined. However, it's our best judgment at this time that somewhere between $25 and $50 million, probably nearer the higher level, would be required by the losing technology to make a meaningful backup contribution.

Mrs. LLOYD. Well, $25 to $50 million, that's a pretty good spread. Are you leaning more toward $50 million?

Mr. JASNY. I'm leaning more toward the upper end of the range, yes, ma'am.

Mrs. LLOYD. For the fiscal year 1986?

Mr. JASNY. Yes.

Mrs. LLOYD. That is fairly close to the agreement that this committee did have with Secretary Hodel.

For both of you, what would be the impact on the present level of staff in the AVLIS Program between April 1 and May 15 if no additional funds are reprogrammed by April 1? I hope that you will indicate which of the affected staff at Livermore for you and Martin Marietta are the contractor personnel and which tasks they are presently carrying out. Who is this going to affect? What work are they doing that will be affected?

Also, I would like for you delineate which AVLIS activities could be carried out by this staff in this 6-week period if additional funds are reprogrammed by April 1. Now we need to know what minimum level of reprogrammed fundings are required to sustain the momentum of AVLIS development by retention of all the staff people through May 15—from May 15, rather, until the end of the fiscal year 1985 budget cycle, consistent with the choice of AVLIS as the selected technology.

Dr. EMMETT. Yes; let me take a cut at that first for both Livermore and Martin Marietta.

mett's numbers, but let me say that we have already been cutting back our AVLIS forces because of fund limitations. We have cut 20 people since January 1. Absent some reprogrammed funds between now and May 15, we would have to accelerate our next cut, which is down to about 125, to 90 people. In other words, we were at about 160 at the beginning of the year. Because of fund shortages we are down to 140 now. We are planning by May 15 to be in the 125 or so level. We will have to drop that down to 90.

The impact of this is that, in our judgment, it would jeopardize our ability to demonstrate a very important milestone in AVLIS, which is this 25 percent of full run time in uranium vaporization and collection. The dollars that we need between now and May 15 are on the order of $1.5 million in reprogrammed funds.

Dr. EMMETT. Madam Chairman, we have to unload in the same sense, we have to come down from basically 265 people to below 100, and that is the major fraction of our core staff gone at that point.

Mrs. LLOYD. What funding level do you feel will be necessary to maintain your continuity?

Dr. EMMETT. We need $6.5 million guaranteed out through the end of May and we need $25 million, not additional but we need $25 million total to see the program through the year and through the decisions. We can phase out the entire AVLIS program in 15 to 18 months and relocate the people; we just cannot phase out things of this magnitude in 3 months.

Mrs. LLOYD. So the total funding would be $8 million?

Dr. EMMETT. Pardon? Yes.

Mrs. LLOYD. $8 million. The DOE said if there was no additional funding the AVLIS program would be cut back about 60 percent.

Dr. EMMETT. Excuse me. A correction: The number is $6.5 million. The $1.5 million for Martin Marietta is included. My mistake.

Mrs. LLOYD. All right. Thank you very much.

Would you comment on the advantages of a smooth transition of the AVLIS program between the development and the verification phases and the additional funding required for 1985 to accomplish a transition?

Dr. EMMETT. Let's presume we win this process selection, and suppose we have to operate on the budgets we have today. We would have essentially taken the people that are out there putting in 80 hours a week and fired them. We would then be in a position of having to go back and try to rehire from wherever they went to work, you know, 150 people.

Mrs. LLOYD. Because you have no slots to put them.

Dr. EMMETT. We have no slots at the Laboratory to put these people into. I mean, the major other two programs at the Laboratory are of course nuclear weapons and the laser fusion program. The only way we could put slots there is to fire people out of the laser fusion program and the nuclear weapons program.

Mrs. LLOYD. You can't reprogram from the Laboratory?

Dr. EMMETT. No.

Mrs. LLOYD. Thank you. Thank you very much. I think that's all I had for you. Thank you very much.

Mr. Jasny, can you think of any further steps that we could take to reduce the cost of the enrichment facilities at Oak Ridge?

Mr. **Jasny**. As I mentioned, we have been working very hard on our nonelectricity costs, and one measure of this is that we have eliminated or we have negated the impact of inflation over the last several years. We have increased the productivity of our use of electricity by more efficient utilization, but clearly in our view the major effort that we should concentrate on is this maximizing our ability to utilize interruptible power and maximizing our cooperative ventures with TVA to get that interruptible power at the lowest possible cost.

Mrs. **Lloyd**. Well, as you know, the Department of Energy believes that further information must be supplied before a deployment decision can be made. Now this is somewhat of a retreat from the initial position that the May 1985 decision was tantamount to a deployment decision for the selected advanced technology.

Now DOE indicates at the present time that the 1985 decision date no longer represents a deployment decision date but rather a decision to concentrate primarily on one technology. In your view, could a deployment decision still be made and timetables set in May 1985 for AGC or AVLIS?

Mr. **Jasny**. I guess I would answer this with three quick points: One, it has been our understanding that the May 15 decision was a technology decision. It is further our understanding—and of course Dr. Emmett presented it, and I know the centrifuge advocacy team is doing the same thing—there will be in the May 15 timeframe presented a deployment plan, a plan aimed at preparing for deployment. So from that standpoint, if you define a plan as answering the deployment question, I believe that will be done.

However, I do think that the point that several of us, I believe all three of us have made so far this afternoon, that what we very badly need is enough information concerning both market and the price of the advanced technology and the marginal cost of electricity or the marginal cost of work, separative work from diffusion plants, all need to be integrated in arriving at a decision to deploy. A plan is in order. I believe such a plan is forthcoming. A decision to deploy will require more information than probably would be available in May.

Mrs. **Lloyd**. So you are saying in your frame of reference a decision to concentrate primarily on one technology in May leaves still room for a final decision on the one technology?

Mr. **Jasny**. Provided it is accompanied with a deployment plan to be constantly reassessed and acted upon when all the data come together.

Mrs. **Lloyd**. So there are still variables——

Mr. **Jasny**. Yes.

Mrs. **Lloyd**. And DOE's interpretation doesn't mean, "Hey, this is it." We are just concentrating more——

Mr. **Jasny**. In terms of deployment, yes.

Mrs. **Lloyd**. On one technology, so that means that there is even less validity for the DOE's decision to reprogram some of this funding, if they are working toward a date of concentration instead of a date of actually making the decision date May 15. Is that correct?

Mr. **Jasny**. Would you mind rephrasing the question?

Mrs. **Lloyd**. Well, this is going to be a time now, according to DOE, that we will concentrate primarily on one technology.

Mr. JASNY. In terms of the technology, in terms of the advanced technology endeavor. At the same time, it's DOE's intention—and it's our intention to work closely with them because we think it's very important—they will continue to assess the market, try to firm up the market, and arrive at a plan which is a businesslike plan, which will enable us to compete in the world market and also reduce the cost of the ongoing process, take full advantage of what we can do with cheaper electricity. All of these have to be integrated to arrive at an actual deployment decision, to the extent that that deployment decision sets the date and the size of a deployment.

Mrs. LLOYD. But my point was that this further justifies the Department of Energy not cutting back on the level of funding on that number two technology.

Mr. JASNY. Absolutely. Yes, ma'am. Absolutely.

Mrs. LLOYD. I thought you were agreeing with me. Thank you very much.

Now if the AVLIS process is chosen over AGC, how many employees at Oak Ridge will be affected?

Mr. JASNY. If the AVLIS is chosen over AGC?

Mrs. LLOYD. That's correct. How many employees would you estimate will be affected?

Mr. JASNY. It's very difficult to answer. Let me try to give you the dimensions of that answer. We have in Oak Ridge roughly.

Mrs. LLOYD. Now I'm talking about Martin and Boeing.

Mr. JASNY. Yes, yes. I understand. We have in Oak Ridge about 1,400 people working on centrifuge activities, GCEP and AGC. We have about 190 to 200 working on AVLIS. Lest I confuse you with that number by comparison with the number that I mentioned earlier in conjunction with Dr. Emmett, I am now speaking of living bodies. I am not speaking of full-time scientific and engineering equivalents, which that other number incorporates indirectly, so in terms of people we have about 190 or so on AVLIS and 1,400 or so on centrifuge.

Mrs. LLOYD. 190 AVLIS, 1,400 on centrifuge.

Mr. JASNY. Right, round numbers.

Mrs. LLOYD. OK, so then if the AGC concept is chosen over the AVLIS concept, that would affect about 190 employees?

Mr. JASNY. Depending on how much money is ultimately allocated. You see, now I am going to give you the difficulty of answering your question.

Mrs. LLOYD. Well, let's say that this money is not reprogrammed and we go on as usual.

Mr. JASNY. Close to that if that were so, if the program had to come to a dead halt. However, I am going to assume that reason will prevail and that the loser will get some fraction of some $50 million or less to continue that. Until we know what that is, until we know what our missions are under this losing category, we won't know how many people we would lose.

The same applies in AGC if you reverse the question: What happens to the loser in AGC? What functions are reassigned to Martin Marietta? Likewise, what happens to GCEP? So until programmatic decisions are arrived at in both of these programs, I can only tell you that our forecast impact is that several hundred people will be affected, lesser numbers in some instances than others, but to come up with a good number requires a better definition of programmatic decisions which are not——

Mrs. LLOYD. Thank you very much. I didn't mean to give you such difficult questions but I do think they are very important for the record.

Mr. JASNY. I agree with you.

Mrs. LLOYD. Thank you.

I think that if it's agreeable we will have about a 10-minute recess and we'll be back. I think it would be good for everybody to have. We'll have a 15-minute recess and reconvene at 3 o'clock. The subcommittee is in recess.

[Recess taken.]

Mrs. LLOYD. The subcommittee will come to order.

I hope you all are refreshed now after your 15-minute recess. Our next panel includes Mr. Kenneth Sommerfeld, vice president, Enrichment/Centrifuge Activities at Martin Marietta Energy Systems; and Mr. Richard L. Grant, president and executive director of Boeing Engineering Co. Southeast; Mr. N.E. Whitchurch, who is general manager of the Centrifuge Equipment Division of Goodyear Aerospace Corp.; and Mr. Charles Rowan, who is director of Enrichment Systems of Airesearch Manufacturing Co.

We thank all of you for being here. We have your complete statements and you may proceed as you wish. I think the time limit is 10 minutes on this. Please proceed, Mr. Sommerfeld.

STATEMENT OF KENNETH W. SOMMERFELD, VICE PRESIDENT, ENRICHMENT/CENTRIFUGE, MARTIN MARIETTA ENERGY SYSTEMS GROUP, INC.

Mr. SOMMERFELD. Thank you, Madam Chairman. I appreciate your invitation to testify. In the interest of the time limit, I will cover some of the parts of the written testimony.

As most of you know, Martin Marietta Energy Systems took over the contract previously held by Union Carbide on April 1, 1984, and assumed the responsibilities for that contract. We inherited all of the personnel teams and resources, the professional team that had been assembled by Carbide, and we have been in the centrifuge business for over 26 years. We have been involved, I think, in almost every phase of that activity, including the operation of the first cascade of CPDF or the set III reliability machines.

In April 1984, Martin Marietta Energy Systems, at the request of various contractors, the Department of Energy, and the centrifuge manufacturers, assumed a project management role in respect to the advanced gas centrifuge team. For clarification, when we talk of AGC we mean set V, or the machine itself that will go into the GCEP facility.

Now our program builds on a strong base of experience, both of prime Government contractors and commercial machine manufacturers, and utilizes commercially available materials. The proposed machine is totally compatible with the existing facility at Portsmouth, OH. It matches the footprint of those machines that have preceded it. Therefore, the major investment already incurred by the Government will be effectively and economically utilized with the deployment of this machine.

In the past year we have made some major progress. All of the rotating hardware subassemblies have been successfully prequalified for high-speed operation. The rotor manufacturing techniques with advanced materials have been successfully demonstrated by the centrifuge manufacturers. Full-size prototype machines have been built. All of the internal components important to performance optimization are now beginning tests at set V conditions. The separative performance models have been verified with actual machine tests at 75 percent of full speed.

The program has as its major objective the demonstration of a fully economic technology, which we expect to be approximately 600 SWU's, by June 1986, capable of providing economical separative work in the mid-$40 range, about $45 per SWU, consistent with all of the existing DOE and PEB guidelines.

Now in respect to questions——

Mrs. LLOYD. Excuse me, Mr. Sommerfeld. Does this include all of the forward costs?

Mr. SOMMERFELD. Those are all of the go-forward costs. They exclude about $170 million of development costs anticipated to take place over the next 3 years.

Mrs. LLOYD. Thank you very much.

Mr. SOMMERFELD. In respect to your questions concerning DOE's proposed 1986 budget, I would like to share my comments as it relates to the AGC program.

The purpose of the AGC program in 1986 and beyond is the aggressive development and demonstration of a reliable, cost-effective technology which can permit the United States to rebuild our major share of the total market. In 1986 I believe it's essential and we are confident of the complete achievement of our machine performance goals.

We will immediately follow that with a convincing demonstration of reliability, involving a large enough number of identical machines in the GCEP facility to show that low risk and high confidence in both machine performance and overall economics of the process. This reliability demonstration also provides the opportunity to demonstrate the complete integration of the advanced gas centrifuge machine into the supporting processes at Portsmouth. It will, in effect, be an early demonstration of a full-scale, fully operable production plant.

Another important aspect of our 1986 program is to demonstrate the ability of the industry to efficiently manufacture these machines. Currently the industrial network built around the centrifuge manufacturers has done an admirable job in the manufacture of the set III machines, and we want to provide the opportunity for whole machine manufacturing experience to provide equally high confidence that the production tolerances, the yields, and the projected costs are realistic and accurate.

We have worked closely with the Department of Energy at both the headquarters and the Oak Ridge operations level on a reexamination of our program with a view of assuring the most cost-effective program possible, and I believe that our plan for 1986 and the out-years is totally supportive of the department's business approach. Our future tasks are well defined. The program we have proposed in response to the concerns and requests of John Longenecker is affordable within the 1986 budget and the out-years. It minimizes redundancy and it involves using the existing expertise, both industrial and the Government contractor base. Its completion does not involve the application of any new engineering principles to achieve the final steps of optimization and economic balance.

Mrs. LLOYD. In other words, you are saying there would be less variables.

Mr. SOMMERFELD. Pardon?

Mrs. LLOYD. There would be less variables or uncalculated expenses.

Mr. SOMMERFELD. Our planned demonstration includes looking at all of the aspects in an effort to minimize the variables or the uncertainties. Yes, that is correct.

Mrs. LLOYD. Thank you.

Mr. SOMMERFELD. I recognize, however, that there are shortfalls in revenues and limits of the net zero appropriations. Of course, we have gone through the need to convert or adjust the GCEP facility from an original 8-building plant to a current 4-building plant. When you add in the need to resolve the reliability questions prior to deployment, these steps have imposed on our program some restraints and circumstances which have altered our planning.

Specifically, our new plan does represent a program delay in deployment of approximately 2 years when compared to our previous plan of last year. This deployment delay, when combined with the completion of the Set III Program in the early part of fiscal year 1986, forces a minimum 15-month delay period during which only development and reliability machines will be produced by the centrifuge manufacturers at a very reduced rate.

Now this delay period has several disadvantages. It brings about staffing reductions for all contractors currently engaged. The low activity makes it difficult to maintain needed core expertise. It does achieve savings in the early years but sacrifices early benefits of rapid scale-up and does not permit a smooth, levelized manpower base that might be otherwise possible. It includes development activities in those areas which are essential for the achievement of the near-term goals but delays promising ideas for future improvements. I believe we have successfully adjusted our program within these restraints.

In the coming year, 1986, fiscal year 1986, we will demonstrate full P3 or set V performance. We will begin deliveries of the first reliability machines to the GCEP facility at the end of fiscal year 1986 and we will be proceeding on all of the engineering and technical support tasks required to permit the Department of Energy to proceed with a request for proposal for a firm, fixed-price contract in fiscal year 1987, leading to the award of this contract in April 1988.

As we look ahead to DOE's plan for the outyears and the opportunity for increased revenues, we are confident that we can be responsive to the market demands. Admittedly, there is uncertainty that makes it difficult to be specific. However, the Advanced Gas centrifuge Program has wide flexibility for deployment, both incrementally in the immediate future at a modest rate or to expand that deployment in a rapid and responsive manner, should favorable increased market demands be realized. Our long-range program includes the understanding that DOE is planning to recapture the major share of the worldwide market by means of significant price reductions. Additionally, we have further improvements in the advanced gas centrifuge which will assure an even more attractive potential in the long term.

In summary, I recognize the financial restraints facing the department and Congress. Given those restraints, I totally support the process selection activities that are underway, and I am confident that the advanced gas centrifuge machine will be chosen. I also endorse the very positive steps spoken of earlier that the department has taken in marketing and in its new business strategy. I am confident of the future of the advanced gas centrifuge machine, and it's important to note that although the machine is an advanced version of the existing set III machine, it utilizes all of the existing balance-of-plant functions that are well known and have been in use in the enrichment enterprise for almost 40 years.

One final but, I think, important note: A comparison of the required outlays for the Advanced Gas Centrifuge Program and plan, when compared against the projected revenues that you would receive from this effort on a stand-alone or separate cost center basis, currently indicates that the Advanced Gas Centrifuge Program will totally pay for itself in approximately 1997 and thereafter return very large positive cash flows to the Department of Energy.

Thank you for your invitation to testify.

[The prepared statement of Mr. Sommerfeld follows:]

STATEMENT OF
KENNETH W. SOMMERFELD
VICE PRESIDENT, ENRICHMENT/CENTRIFUGE
AND PROGRAM MANAGER, ADVANCED GAS CENTRIFUGE PROGRAM
MARTIN MARIETTA ENERGY SYSTEMS, INC.

BEFORE THE
COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION
U.S. HOUSE OF REPRESENTATIVES
FEBRUARY 28, 1985

Madam Chairman, Members of the Committee, I am Ken Sommerfeld, Vice President of Centrifuge Enrichment at Martin Marietta Energy Systems, Inc., and Program Manager of the Advanced Gas Centrifuge Program.

I appreciate your invitation to testify and to share with you my views concerning the Department of Energy's enrichment program as it relates to the Advanced Gas Centrifuge program portion of the FY-86 proposed budget and planning for the out years.

As most of you know, Martin Marietta Energy Systems, Inc., took over the Union Carbide Corporation contract on April 1, 1984, and assumed responsibilities as a prime Government contractor to the Department of Energy. This contractor change continued to utilize all of the resources and professional team that had been assembled by Union Carbide Corporation. We have been in the centrifuge business for over 26 years. We were the first industrial contractor involved in the technology and development scale-up from the initial government-supported centrifuge work done at the University of Virginia. During that time, we have gained extensive experience with programs in Research and Development, Centrifuge Theory, Machine Development, Process Integration, Engineering, Component Manufacturing, and the testing and optimization of full-size development machines. I believe we have had experience in virtually every phase of the program; including the operation of the first cascade of Set III reliability machines in the CPDF facility at Oak Ridge.

In the past year we have made major progress in the Advanced Gas Centrifuge program.

1. All rotating hardware subassemblies have been successfully prequalified for high-speed testing.

2. Rotor manufacturing techniques with the advanced material have been successfully demonstrated by the Centrifuge Manufacturers.

3. Full-size prototype centrifuges have been fabricated.

4. Internal components important to performance optimization are under tests at Set V conditions.

5. Material properties from two vendors have shown significant improvement, confirming our prior projections.

6. Separative performance models have been verified with actual machine tests at 75% of P3 speed, and currently we are beginning the testing of several full-size Advanced Gas Centrifuge machines at speeds approaching the program goal.

The program has as its major objective the demonstration of a fully economic AGC technology, which we expect to be about 600 SWU/yr, by June 1986.

In respect to your questions concerning the Department of Energy's proposed FY-86 budget, I would like to share my comments with you relating to the Advanced Gas Centrifuge portion of that proposed budget. My comments, of course, assume an Advanced Gas Centrifuge process selection in May of 1985. The purpose of the DOE/AGC program in '86 and beyond is the aggressive development and demonstration of a reliable, cost-effective technology which can permit the United States to rebuild our major share of the total market. In FY-86 I believe it is essential, and I am highly confident, that we will demonstrate the success of our technology: that is, the complete achievement of our machine performance goals. We will also begin a convincing demonstration of reliability, involving a large enough number of identical machines in the GCEP facility to show the low risk and high confidence in both machine performance and the overall economics of the process. Demonstrating reliability is of course critical to economics because we must show that our failure rates and maintenance costs are in practice what we are projecting. This reliability demonstration will also provide the opportunity to demonstrate the complete integration of the Advanced Gas Centrifuge machine into the supporting processes and plant at Portsmouth, Ohio. This will be an early demonstration of a full-scale, fully-operable production plant.

Another important aspect of our '86 program is to demonstrate the ability of the industry to efficiently manufacture these machines. Currently, a broad industrial network principally built around the three Centrifuge Manufacturers has done an admirable job in the manufacture of the Set III machine. There are, of course, some important design changes in the Set V or advanced machine, and although the new design parts are currently being manufactured, we want to provide the opportunity for whole-machine manufacturing experience to provide high confidence that production tolerances, yields, and projected costs are realistic and accurate. The AGC program will in FY-86 assure that the GCEP facility at Portsmouth, Ohio, operated by the Goodyear Atomic Corporation, has the appropriate Balance-of-Plant, R/A, and support equipment required to efficiently use this machine. We believe that these steps address all of the essential elements and are currently incorporated into our proposed program utilizing FY-86 funding. The program is designed to provide the Department of Energy high confidence concerning the deployment of the Advanced Gas Centrifuge machine.

We have worked closely with the Department of Energy at both the Headquarters and the Oak Ridge Operations level on a re-examination of our program with a view of assuring the most cost-effective program possible; and I'm convinced our plan for FY-86 and the out years is supportive of the Department of Energy's business approach. Future tasks are well defined. The program we have proposed in response to the concerns and requests of John Longenecker is affordable within the requested FY-86 budget. It minimizes redundancy and/or duplication, it involves contractor consolidation and/or reductions, and it utilizes the existing expertise of both the industrial and government contractor base. Its completion does not involve the application of any new engineering principles to achieve final optimization and economic balance.

I recognize, however, that the short-falls in revenue, the limits of net zero appropriations, the need to convert or adjust the GCEP facility from the prior 8-building plant to a 4-building plant, when combined with the need to resolve reliability questions prior to deployment decisions, have imposed on our program some restraints and circumstances which have significantly altered our planning. Specifically, the new plan for AGC will represent a program delay in deployment of approximately two years when compared against our previous deployment plan. This deployment delay, when combined with the completion of the Set III program in the early part of FY-86, forces a minimum 15-month period during which only development and reliability machines will be produced by the Centrifuge Manufacturers at a very reduced rate. This delay period has several disadvantages. It will bring about significant staffing reductions for all of the contractors currently engaged in the centrifuge program, and the low activity makes it difficult to maintain needed core expertise of critical personnel for later production activities. It achieves savings in the early years but sacrifices the early benefits of rapid scale-up, and it does not permit a smooth levelized manpower base that might be possible otherwise. It includes development activities to those areas which are essential for the achievement of the near-term goals, but delays promising ideas for future improvements until later in the program. I recognize, however, the urgency of price reductions and other economic restraints facing the Department of Energy and Congress, and given the financial conditions anticipated as a result of revenue short-falls in FY-86, I believe we have successfully adjusted our program within these restraints.

In the coming year, FY-86, we will demonstrate full P3 performance. We are confident that the commercial material supplied by our vendors will meet the design strength specifications. We will have prepared for the Department of Energy a centrifuge machine design package available for initial low-rate contract procurement. We will begin deliveries of the first reliability machines to the GCEP facility at the end of FY-86 and we will be proceeding on all of the engineering technical support required to permit the Department of Energy to proceed with a request for proposal for a firm fixed-price contract in FY-87, leading to the award of this contract in April 1988.

As we look ahead to the Department of Energy's plan for the out years, and the opportunity for increased revenues, I am confident that the Advanced Gas Centrifuge program can be responsive to the market demands. Admittedly, uncertainty in the out year market projections make it difficult to be specific about potential impacts of long-term funding; however, the Advanced Gas Centrifuge program has wide flexibility for deployment, both incrementally in the immediate future at a modest rate or to expand that deployment in a rapid and responsive manner should favorable increased market requirements be realized. Our long-range program includes the understanding that the Department of Energy is planning to recapture a major share of the world-wide market by means of significant SWU price reductions. Additionally, we have already identified further improvements in the Advanced Gas Centrifuge machine which will assure an even more attractive potential in the long-range deployment plans as revenues become available.

In summary, I recognize the financial restraints facing the Department and the Congress, and given those restraints, I endorse the FY-86 financial requests of the Department of Energy. I totally support the process selection activities currently under way, and I am confident that the Advanced Gas Centrifuge machine will be chosen. I also endorse the very positive steps the Department has taken to cope with the international market place with a strategy which includes adoption of sound business principles to the enrichment enterprise, the implementation of the new utilities contracts, the continued and even accelerated efforts to lower cost of operation of the existing diffusion plants through the use of unfirm or off-hours power, and the aggressive marketing posture that is being pursued by the Department. I am confident of the future of the Advanced Gas Centrifuge machine, and it is important to note that although this machine is an advanced version of the existing Set III machine, it utilizes all of the existing Balance-of-Plant functions that are well known and have been in use in the enrichment enterprise for over 40 years.

One final, but important, note---a comparison of the required outlays for the Advanced Gas Centrifuge deployment plans, when compared against the projected revenues on a stand-alone or separate cost-center basis, currently indicates that the Advanced Gas Centrifuge program will totally pay for itself by approximately 1997 and thereafter return a positive cash flow stream to the Department of Energy.

Thank you for your invitation to testify, and I would be happy to try to answer any questions you might have.

Mrs. LLOYD. Thank you, Mr. Sommerfeld.

Our old friend, Mr. Dick Grant, is with us today. Glad to have you also, Dick. Please proceed.

STATEMENT OF RICHARD L. GRANT, PRESIDENT AND EXECUTIVE DIRECTOR, BOEING ENGINEERING CO. SOUTHEAST, INC.

Mr. GRANT. Thank you, Madam Chairman. Thank you. I appreciate that.

I am Richard Grant. I am the president of the Boeing Engineering Co. Southeast, which is a wholly-owned subsidiary of the Boeing Co. Boeing is one of three companies engaged in the manufacture of centrifuges of the current design, in that case called Set III, and research and development in the next generation design called Set V. These two activities are the only contractual activities Boeing is involved in with DOE on the centrifuge programs.

I'll address each of the subjects for which you requested comments. I first, however, must comment on the current centrifuge program because it bears so heavily on the future.

Boeing conducts its centrifuge operations in specially designed facilities in Oak Ridge, TN. As of today, there are 436 people employed by Boeing in these facilities which opened in 1981. A total of $70 million of Boeing funds were used to design, construct, and equip these facilities and they are located on Boeing-owned land in the City of Oak Ridge, TN.

We are proud of our performance on the centrifuge program to date. Our contract completion is ahead of schedule in every respect. Some components have been manufactured in their entire contract quantities already and others will be completing rapidly over the next few months. We deliver centrifuges in segments or subsystems called end items. By mid-May when the selection is made on this first phase contract, only 6 of the 17 end items that we deliver will remain to be completed. By early November only rotor deliveries will remain, and the employees remaining on the Set III Program will number about 50. A somewhat smaller number will remain on the set V centrifuge R&D program by the end of the fiscal year.

The plant was designed and built to provide efficient centrifuge manufacturing capability of about 50 units per month, with the design features for expansion. The current contract rate is about 30 units per month. At this rate, our current cost is about $70,000 per machine, with the learning curve improvement continuing as predicted.

The figure that is contained in my prepared testimony is the learning curve as it has performed from the beginning of operations on the centrifuge program. The important feature here and the reason for my emphasis, of course, is that that is the curve that we manage to, that we control our costs to, that we use to demonstrate that learning has occurred, and that we are able then to use to confidently predict what the cost of centrifuges of like design in the future will be.

The end of the curve you see there will occur shortly after Christmas of this year. Nearly all the fine, highly-trained centrifuge work force will be gone at that time. Nearly all the centrifuge manufacturing tools and equipment will be idle, and the lights will be out in 80 percent of the facility space.

What we're trying to do is to provide the maximum advantage of that learning curve that we have spent 5 years and that DOE has worked with us on to DOE: That is, manufacturing at the rates which match as nearly as possible those for which the facility, equipment, and management systems were designed. That should result in the lowest cost to the Government in the near term.

As subsystems are delivered in their full contract quantity, that portion of the facilities and equipment will be placed in some condition from which it could recover for some period of time but which constitutes the lowest cost for maintenance and fixed-cost burdens to the Government. Those items of equipment needed for a small R&D effort will be identified and consolidated so that they can be properly accounted for.

We still expect to complete our entire contract within a management estimate that my managers and I made at completion, and the cost we estimated at that time almost 3 years ago. As work is completed, the people will be removed from the program and the equipment and tooling shut down. I also don't have any place else to send these people, by the way, but they will be off the program and they will come off at the rates that are required to keep our costs within control.

The cost of idle facilities, equipment, and tooling either then continues as an overhead cost burden to DOE if they want that to happen, or it is returned to Boeing's account for other uses or disposal. As far as the portion of the fiscal year 1986 budget which Boeing will bill DOE for—that will be in completion of the phase 1, set III contract—that will be $4.5 million. The only other contractual obligation DOE has to Boeing is the unamortized balance of the special-purpose equipment cost which was borne up front by Boeing and the other closeout costs such as decontamination and cleanup of the facility and the security things, which will total about $15 million, the balance we agreed to put at risk when we undertook this program. R&D contracts are negotiated annually, and whether or not those are continued into fiscal year 1986 in Boeing's case will be as DOE desires.

I have talked about the learning curve. That's the most important loss, as I see it, for the DOE. If the kind of delay that is now anticipated occurs, the learning curve will have to be experienced again at a cost similar to that of the set III if the set V centrifuge is to be deployed. Set V program costs will increase accordingly.

Moving on to the Advanced Gas Centrifuge Program, the Set V Development Program is structured to provide successively more capable centrifuges as we go, not to produce a single centrifuge which, if switched on, immediately meets all the set V requirements. The set V Advanced Gas Centrifuge Program is proceeding in its development activities very much as I would expect it to in this kind of a program.

This means that great and understandable progress toward the ultimate goal is being made. It doesn't, however, mean that everything goes exactly as predicted at each step. If everything went exactly as predicted by analysis, development programs would be a very easy thing.

Do we know exactly how the final design will perform? Of course not. There are very few absolutes in the advanced technology business. Are there fatal flaws in the technology? If there are, I have not seen them. You may be sure that Boeing has little interest in participating in a program we think may fail.

We are manufacturing and testing set V hardware every day. Design details change frequently. The fact that changes occur and the hardware works better than before is the very evidence one seeks in a development program. This is the evidence that provides those of us managing the program with the assurance that the targets can be met.

We have fabricated about 25 of the set V type rotors. Were they all capable of the ultimate set V performance? No. They were, however, all capable of performance greater than set III performance, and we now have rotors in hand that will be capable of very close to set V performance and perhaps up to set V performance if everything goes exactly as planned.

Going exactly as planned means a lot of things have to work together as planned. We have, for example, had instances where test hardware, the hardware we were testing, was perfectly fine but the test equipment and instrumentation gave us problems. People occasionally are imperfect, but fortunately those instances have been few. Fortunately, this program doesn't threaten anyone's life or limb in its testing, nor is the hardware prohibitively expensive. Testing can therefore proceed quickly, as can changes when anomalies are detected and corrected.

In the very recent past DOE has indicated that it intends to restructure the program in such a way that about 2 years of gap will be experienced in the centrifuge production. This is to allow additional time for removing technical uncertainty while evaluation and demonstration testing continues. Such a delayed program also requires less money to be spent over the next 3 fiscal years.

Shortly before announcing these plans, then-Secretary of the Department of Energy, Mr. Don P. Hodel, contacted Mr. T.A. Wilson, the chairman of the board of the Boeing Co., to apprise him that changes were coming, that long-lead procurement would not be authorized by a 2-year delay, but that we were not to interpret this as any lessening of DOE's dedication to the centrifuge program.

Mr. Wilson advised Mr. Hodel that Boeing wanted to help with any program problem that he had, and that under the circumstances Boeing recommended that DOE reduce from three centrifuge manufacturers down to one and adopt a future program analogous to the Department of Defense leader/follower type contracting. Mr. Wilson added that if this approach were adopted and Boeing were not the remaining CM, we would commit to competing for the follower role at such time as DOE determined it had sufficiently mature design to proceed. Mr. Wilson also committed Boeing to help with restructure planning.

I believe we have done all we promised and have provided DOE with as much flexibility as possible in doing so.

Key to retaining a viable centrifuge program is retaining a reasonable business base. Remember that the set V centrifuge is nearly as dependent on manufacturing technology as it is on science-based technology. We believe that by manufacturing and operating the best machines possible as early as possible, the maximum benefit will be realized. There will undoubtedly be something better on the horizon at all times. That's the feature of technology that fuels the great engines of this Nation. The fire is, however, sustained by what is built and demonstrated and in use at each step.

In 1977 we believed that the centrifuge program was good and rational, as we still do. We were willing to put our resources at risk, No. 1 because we thought we could do a good job but, No. 2, because the program offered a reasonable business base. Absent such a business base, DOE would probably be better served by contractors who do not have private investment in the program.

Reduction of the work force is a terrible thing to experience, not only for the people who are losing their jobs but for the management and others as well. Productivity and quality are hard to maintain, along with morale, under these circumstances. The best work force will be one facing less uncertainty. For these reasons, we recommend that DOE use its available funds to structure a program which channels those funds to fewer contractors. This will not only produce the most motivated contractor and work force but do so at the least cost as fixed-cost obligations are eliminated.

I believe that DOE is taking steps in this direction and I applaud their doing so. I do not, however, agree that the requirement for long-lead authority nor technical and economic uncertainty are appropriate culprits in the need for change in this program. Revenue problems are appropriate culprits, however, and as those fall below the threshold for continuing what was in our view a good program, then a program which provides the greatest hedge against a near-term shortfall with the best long-range payoff is clearly indicated.

Specific features of the fiscal year 1986 centrifuge program are still being planned. Boeing's role in this program, if any, will derive from that planning and its implementation. The timing of the PEB selection adds uncertainty to our program in the long haul.

On the laser isotope separation process subject, those of us involved in the PEB-related activities have been required to sign nondisclosure agreements which prevent us from public disclosure of information related to those deliberations. Since anything I would say regarding the AVLIS technology would contain information related to those deliberations, I must respectfully decline comment.

Hurrying on, I always say something about conservation and remind people that this program was put together to save something like 2,000 kilowatt-hours per SWU, as it is still capable of doing, and that's a lot of electricity. It is annually about 1 percent of the total electricity generated in the United States.

In summary, I believe that the Gas Centrifuge Enrichment Program is sound technology and represents the best way to meet the enterprise goals of DOE for many years into the next century. I believe it offers a cost-effective hedge against future changes in all elements of the marketplace—energy costs, inflation, foreign exchange rates, and demand variables. I further believe its demonstrated capability is a sound basis for proceeding.

I also understand that DOE's revenue constraints in today's environment must be viewed as absolute, and therefore that may dictate program changes from time to time. You and DOE both may depend on Boeing to continue to advocate the least costly way to proceed to a successful program and to assist and support the DOE in that program.

The support of committee over the past years in the uranium enrichment enterprise has been greatly appreciated. We hope that we have and will continue to earn that support.

I thank you.

[The prepared statement of Mr. Grant follows:]

STATEMENT
MR. RICHARD L. GRANT
PRESIDENT, BOEING ENGINEERING COMPANY SOUTHEAST, INC.
OAK RIDGE, TENNESSEE
before
THE SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
FEBRUARY 28, 1985

Madam Chairman, distinguished committee members and committee staff, my name is Richard L. Grant. I am president of Boeing Engineering Company Southeast, Inc., a wholly-owned subsidiary of The Boeing Company. I thank you for this opportunity to comment on the Gas Centrifuge Enrichment Program. Boeing is one of three companies engaged in the manufacture of centrifuges of the current design called Set III and Research and Development in support of the next generation design, called Set V. I will address each of the subjects for which you requested comments. I must first, however, comment on the current centrifuge program because it bears so heavily on the future.

Current Centrifuge Program

Boeing conducts its centrifuge operations in specially designed facilities in Oak Ridge, Tennessee. As of today

435 people are employed by Boeing in these facilities which were opened in 1981. A total of $70 million of Boeing funds were used to design, construct and equip these facilities and they are located on Boeing-owned land. They represent the largest single private sector investment in the City of Oak Ridge.

We are proud of our performance on the DOE Centrifuge Program. We are on or ahead of contract schedule for every end item and component of the Set III machine. Some components have been delivered in their total contract quantities and others will complete over the next few months. By mid May, only 6 of 17 end item deliverables will remain to be completed. By early November, only rotor deliveries will remain and employees remaining on the Set III program will number about 50. A somewhat smaller number will remain on DOE Set V centrifuge R&D work by the end of this fiscal year.

Our plant and equipment were designed and built to provide efficient centrifuge manufacturing capability of about 50 units per month with design features for cost-effective expansion. The current contract rate is about 30 units per month. At this rate our current cost is about $70K per machine with learning curve improvement continuing as predicted. Figure 1 shows the learning curve experienced since the start of operations. Work on the Set III centrifuges under the Phase 1 contract is completing

TOTAL MACHINE LABOR HOURS
ACTUALS THROUGH JANUARY 31, 1985

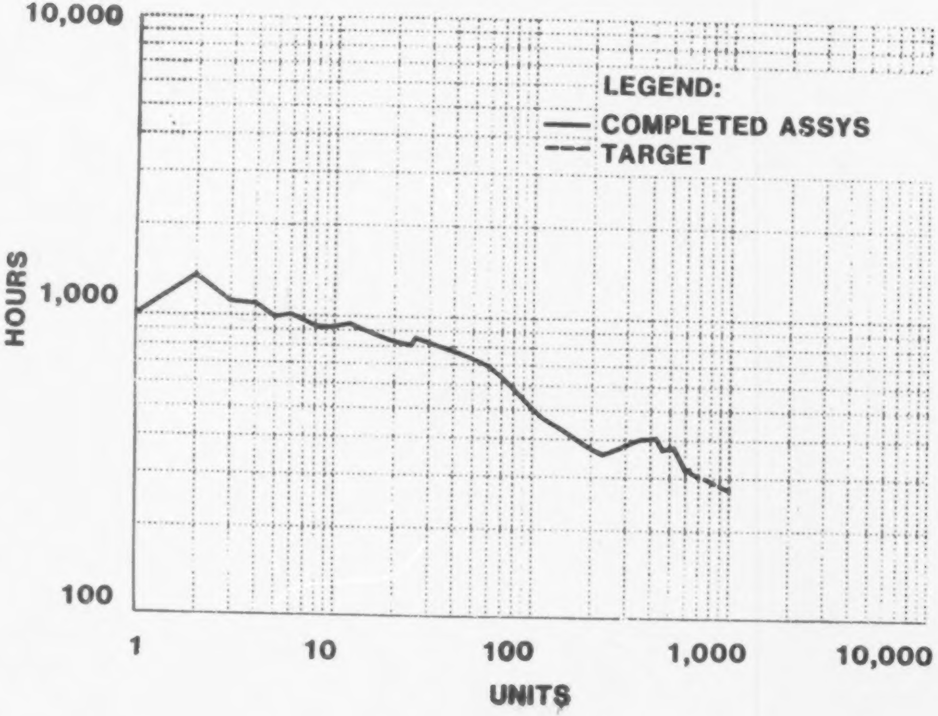


FIGURE 1

quickly. By Christmas of this year nearly all of the fine, highly trained centrifuge manufacturing workforce will be gone. Nearly all of the centrifuge manufacturing tools and equipment will be idle and the lights will be out in 80% of the facility space.

Boeing planning is based on providing the maximum advantage to DOE of the learning curve improvements made over the last five years. We plan to complete manufacturing at rates which match, as nearly as possible, those for which the facility, equipment and management systems were designed. This will, we believe, result in the lowest near-term cost to the government. As subsystems are delivered in their full contract quantity, that portion of the facilities and equipment used in their manufacture will be placed in a condition which minimizes the cost to the government for those fixed cost burdens which continue until the end of the centrifuge manufacturing effort. Disposition instructions will be sought from DOE for that Special Purpose Equipment no longer being utilized and for which DOE becomes obligated for the unamortized balance. Those items of equipment needed for "a small R&D effort" will be identified and consolidated in such a way as to permit a crisp redetermination of the fixed cost base for that R&D effort.

As a practical matter, our hardware deliveries will continue until the contract closeout date because of rotor balancing and packaging. All other contract end items will be completed prior to this date as has been planned for some time now. (Manufacturing schedules require completion of most of the components well before delivery.) We still expect to complete our contract within the Management Estimate at Completion (MEAC) costs we made almost three years ago.

As work is completed, people will be removed from the program and the equipment and tooling shut down. The cost of idle facilities, equipment and tooling either continues as an overhead cost burden to DOE or is returned to Boeing's account for other uses or disposal.

As relates to the FY 1986 DOE budget, Boeing's billings to DOE for Set III centrifuge manufacturing under the current Phase 1 contract will be about $4.5M. The only other contractual obligation DOE has to Boeing is the unamortized balance of the Special Purpose Equipment cost which was borne up front by Boeing and the other closeout costs which total about $15M. R&D contracts are negotiated annually and may or may not be continued as DOE decides.

Perhaps the most important aspect of these circumstances for DOE is the loss of the impressive learning curve improvements made on the Set III program. The learning curve will have to be experienced again at a cost similar to that of Set III if the Set V centrifuge is to be deployed. The Set V program costs will increase accordingly.

Advanced Gas Centrifuge Program

The Set V AGC development program is structured to provide successively more capable centrifuges as we go, not to produce a single centrifuge which if switched on immediately meets all the Set V requirements. The Set V Advanced Gas Centrifuge program is proceeding in its developmental activities very much as I would expect in such a program. This means that there is great and understandable progress toward the ultimate goal. It doesn't, however, mean that everything goes exactly as predicted at each step. If everything went exactly as predicted by analysis, development programs would be very easy. Do we know exactly how the final design will perform? Of course not. There are very few absolutes in this business. Are there fatal flaws in the technology? If there are, I've not seen evidence of them. You may be sure that Boeing has no interest in participating in a program we think may fail.

We are manufacturing and testing Set V hardware every day. Design details change frequently at this stage. The fact that changes occur and the hardware works better than before is the very evidence one seeks in a development program. It is this evidence that provides those of us managing the program with the assurance that the targets can be met.

We have fabricated about 25 rotors of the Set V type. Were they all capable of the ultimate Set V performance? No. They were, however, all capable of performance greater than Set III performance and we now have rotors that will be capable of very close to Set V performance - perhaps up to Set V performance if everything goes exactly as planned. Going exactly as planned means a lot of things have to work together as planned. We have, for example, had a number of instances where the Set V hardware we were testing was fine but the test equipment and instrumentation gave us problems. People are occasionally imperfect as well, but instances of human error have been encouragingly few. Fortunately, this program does not threaten life nor limb in its testing nor is the hardware prohibitively expensive. Testing can therefore proceed fairly quickly and correction of anomolies is also quickly accomplished.

In the very recent past DOE has indicated that it intends to restructure the program in such a way that about 2 years of gap will be experienced in the centrifuge production program. This is to allow additional time for removing technical uncertainty while evaluation and demonstration testing continues. Such a delayed program also requires less money to be spent over the next three fiscal years.

Shortly after announcing these plans the Secretary of the Department of Energy (Mr. Donald P. Hodel) contacted The Boeing Company Chairman of the Board, Mr. T. A. Wilson, to apprise him of coming changes. Mr. Wilson advised Mr. Hodel that Boeing wanted to help with any program problem he had and that under the circumstances, Boeing recommended that DOE reduce from three Centrifuge Manufacturers (CMs) to one and adopt a future program analogous to Department of Defense Leader/Follower type contracting. Mr. Wilson added that if this approach were adopted and Boeing was not the one remaining CM, we would commit to competing for the "Follower" role at such time as DOE determined it had a sufficiently mature design to proceed. Mr. Wilson also committed Boeing to help with restructure planning.

I believe that we have done all we promised and have provided DOE with as much flexibility as possible in doing so. Key to retaining a viable centrifuge program is the retaining of a reasonable industrial base. The Set V centrifuge is nearly as dependent on manufacturing technology as it is science-based technology. We believe that by manufacturing and operating the best machines possible, as early as possible, the maximum benefit will be realized. There will undoubtedly be something better on the horizon at all times. That is the feature of technology that fuels the great engines of this nation. The fire is, however, sustained by what is built and demonstrated at each step.

We believe, as we did in 1977 that the centrifuge program is good and rational. We were willing to put our corporate resources at risk because we thought we could do a good job and because the program offered a reasonable business base. With the absence of such a business base, DOE needs would probably be better served by contractors who do not have private investment in the program.

The reduction of a workforce is always an agonizing experience and not just for those losing their jobs. Morale, productivity and quality are hard to sustain in such circumstances. The best workforce will be the one facing less uncertainty. For these reasons, we have recommended that DOE use its available funds to structure a program which channels the funds to fewer contractors. This will not only produce the most motivated contractor and workforce but do so at the least cost as fixed cost obligations are eliminated. I believe that DOE is taking steps in this direction and I applaud their doing so. I do not, however, agree that the requirement for long-lead authority nor technical and economic uncertainty are appropriate culprits in the need for change in this program. Revenue problems are appropriate culprits, however, and as those fall below the threshold for continuing what was, in our view, a good program, then a program which provides the greatest hedge against a near-term shortfall with the best long-range payoff is clearly indicated.

The specific features of the FY 1986 Centrifuge Program are still being planned. Boeing's role in this program, if any, will derive from that planning and its implementation. DOE has requested input from most of the program participants and is considering these inputs in its planning. The timing of the Process Evaluation Board (PEB) deliberations adds uncertainty to any long range plans for obvious reasons. I believe a plan which can be deployed at minimum cost is being derived and that all the participants have given this planning their best to maximize DOE flexibility and keep the cost of delay down.

Laser Isotope Separation Process

Those of us involved in the PEB related activities have been required to sign non-disclosure agreements which prevent us from public disclosure of information which relates to the PEB deliberations. Since anything I would say regarding the AVLIS technology would contain information related to these deliberations, I must respectfully decline comment.

We expect AGC to win the competition implicit in the PEB process and believe that would be the best result for DOE and the country.

Conservation Potential of the Centrifuge Program

Each year in my statements before this Committee and others, I remind my audience that part of the original motivation for the Centrifuge Program was energy conservation. I recognize that energy surpluses and stable to declining prices for energy have combined to make dedication to Energy conservation hard to sustain. We at Boeing still believe saving energy is a good idea--a view shared by many others in all sectors of U.S. society and one I know is shared by this committee. The private sector has spent billions to make its facilities and products more energy efficient. Private citizens have spent millions to make their homes and transportation more energy efficient and the nation's utilities are doing their best to encourage and aid that spending to conserve more. Private industry is very successful when it realizes an energy efficient improvement of a factor of 1.3 to 1.4. Private citizens with a maximum effort can realize a factor of 2 improvement. The centrifuge program provides a factor of 15 to 17 improvement or a savings of about 2000 kilowatt-hours of electricity for each Separative Work Unit (SWU) of enriched uranium produced. For a Set V centrifuge plant which will produce 13.2 million SWU this represents more than 25 billion kilowatt-hours of electricity annually. A conservation measure of these proportions should be implemented and it seems that delay should be avoided. The centrifuge remains the most energy efficient process available for uranium enrichment.

Summary

In summary I believe that the Gas Centrifuge Uranium Enrichment program is sound technology and represents the best way to meet the DOE Enterprise goals for many years into the next century. I believe it offers a cost effective hedge against future changes in all elements of the marketplace; energy costs, inflation, foreign exchange rates and demand variables. I further believe that its demonstrated capability is a sound basis for proceeding.

I also, however, understand that DOE's revenue constraints must be viewed as absolute in todays environment and that their efforts to conduct a businesslike enterprise in this environment may dictate program changes from time to time.

This Committee and the DOE may depend on Boeing to continue to advocate the least costly way to proceed toward a successful centrifuge program and to assist and support the DOE program which does that.

The support this Committee has given the Uranium Enrichment program over the past years is greatly appreciated. We hope we have and will continue to earn that support.

I thank you for your attention and will be happy to try to answer any questions you have.

Mrs. LLOYD. Thank you very much, Mr. Grant.
Mr. Whitchurch.

STATEMENT OF NORMAN E. WHITCHURCH, GENERAL MANAGER, CENTRIFUGE EQUIPMENT DIVISION, GOODYEAR AEROSPACE CORP.

Mr. WHITCHURCH. Madam Chairman, we appreciate your invitation to testify at this hearing and to give you our views concerning the Department of Energy's enrichment program. Dr. E.O. Hartig, our vice president, had intended to testify today but compelling personal reasons have prevented this. Please accept his sincere apologies.

We are convinced a strong, cost-competitive, assured domestic uranium enrichment supply is vital to U.S. security and national interests. For many years the U.S. uranium enrichment enterprise had little competition and enjoyed the dominant position in the domestic, indeed the world market, not unlike the U.S. auto and steel industries. Like the auto and steel industries, foreign competition has gained a major share of the enrichment market.

Timely, decisive action is required now to restore the strength of the U.S. enrichment enterprise. We applaud DOE actions to operate the enrichment enterprise in accordance with sound business practices, to lower costs, and to be more responsive to their customers' needs. DOE's recent initiative in offering and negotiating new utility contracts was both timely and effective. This is an important first step in maintaining a healthy U.S. enrichment enterprise and defeating the inroads of foreign competition.

A large segment of the market remains uncommitted, however, and DOE must aggressively pursue this market while continuing to meet the needs of its present customers, else they too will be lost. We are concerned that by delaying the deployment of new, more cost-effective, less energy-intensive enrichment technology, DOE will continue to lose market share, both domestic and foreign. The United States will become more dependent on foreign energy sources, jobs will be lost, and our influence in world nuclear affairs will lessen.

Reliance on the long-range competitive cost of gaseous diffusion SWU's in the meantime is very risky. The gaseous diffusion plants have made very commendable reductions in operating costs. Their projections of future costs, however, are heavily dependent on the price of electric power that is subject to unforeseen, rapid cost increases due to energy shortages, to increases in the cost of fuel, or to unstable world political and economic conditions.

We realize that under zero appropriations limitations with high Government deficits, DOE finds it difficult to carry forward the deployment of the advanced gas centrifuge at a pace that is most cost-effective, a pace that would also put the United States in the best competitive position. However, DOE and Congress should look at the value of operating the enrichment program as a business. Some added expenditures in the near term will save dollars in the future, and seizing the opportunity now will defeat foreign competition.

No well-managed business would undertake construction of a major new plant for which the completion schedule was entirely dependent on annual cash-flow. It is fundamental that the earlier a new plant starts producing product, the more cost-effective it will be.

We at Goodyear Aerospace are convinced the technical development requirements of the advanced gas centrifuge are reasonable and manageable, and the AGC machines should be put into production without delay. By so doing, serious and costly production interruptions are avoided. The layoff of trained employees and costs of rehiring, retraining, and reclearing new employees is avoided. Delays in the deployment of the advanced gas centrifuge create the perception in the minds of DOE's utility customers of AGC being as risky as AVLIS, and create doubts DOE will ever deploy more cost-effective technology.

AGC is based on over 25 years of development and a solid base of proven, full-scale operation technology. Test results on the AGC program in the past year have continued to confirm the projected gas dynamics and performance projections. Fabrication experience has similarly confirmed our ability to manufacture the new, more cost-effective centrifuge machines. Operating experience in the GCEP plant has been outstanding and has proven that the plant design and the plant control systems are sound, safe, reliable, and ready.

In conclusion, Madam Chairman, let me address the questions in your letter of invitation.

Timely, aggressive deployment of the advanced centrifuge must begin in fiscal year 1986 or the U.S. enterprise will continue to lose market to foreign competition, market that may never be recovered. We know the Japanese have been aggressively developing centrifuge technology and are committed to deploy—that's not the timer, I hope.

Mrs. Lloyd. That's my timer.

Mr. Whitchurch. And are committed to deploy a centrifuge enrichment plant. We know URENCO is considering accelerating the planned doubling of its enrichment capacity. We must not stand by and allow foreign competition to overrun our domestic market as well as the international market.

The advanced centrifuge is ready for deployment to begin now. In our candid assessment, the AVLIS technology shows promise for the future but is still in the laboratory stage of development. Centrifuges, however, are running now in the plant at Portsmouth. There are major uncertainties in the AVLIS technology and in the AVLIS capital and operating costs that will require years to resolve. In contrast, three manufacturers have produced 1,500 set III centrifuges, over 900 of which are installed in GCEP and will be put on throughput this spring. The U.S. Government has invested $2.6 billion in GCEP, a plant that is on schedule and within budget. This experience gives us confidence in the capital, operating, and SWU costs for GCEP with advanced centrifuges.

If I may quote from the February 11, 1985, issue of Forbes magazine, "Sooner or later—in the mid-1990's, in the late 1980's, even—the United States will almost certainly need to begin planning large central power stations. But if not coal and if not oil and/gas, then what? Everywhere else in the world the answer is nuclear. Elsewhere in the world nuclear is a low-cost, reliable, environmentally impeccable form of energy." And so it must be in the United States. Nuclear power is safe, clean, abundant, and cost-effective. It must be used to provide an increasingly larger share of our needs for power.

We believe the fiscal year 1986 budget for GCEP, including R&D, must be at least $460 million, and future budgets should gradually increase to a peak of about $675 million in 1989. These budget levels are needed for timely deployment of the gas centrifuge in order to provide an aggressive response to foreign competition and to assure the continued strength of the U.S. enrichment enterprise. If necessary, some means must be found to relieve DOE of the constraint for net zero appropriations.

Decisive, farsighted action by DOE and Congress is required now. We urge Congress to provide at least the $450 million in fiscal year 1986. Anything less will risk the further serious inroads of foreign competition and will significantly increase the capital costs of GCEP.

Thank you.

[The prepared statement of Dr. Hartig follows:]

STATEMENT
DR. E. O. HARTIG
VICE PRESIDENT, GOODYEAR AEROSPACE CORPORATION
SUBSIDIARY OF
THE GOODYEAR TIRE & RUBBER COMPANY
BEFORE
THE SUBCOMMITTEE ON ENERGY RESEARCH & PRODUCTION
U.S. HOUSE OF REPRESENTATIVES
FEBRUARY 28, 1985

MADAM CHAIRMAN, MEMBERS OF THE COMMITTEE, I AM DR. E. O. HARTIG, VICE PRESIDENT OF GOODYEAR AEROSPACE CORPORATION, A MANUFACTURER OF CENTRIFUGE ENRICHMENT EQUIPMENT FOR THE DEPARTMENT OF ENERGY.

I HAVE WITH ME NORM WHITCHURCH, GENERAL MANAGER OF OUR CENTRIFUGE EQUIPMENT DIVISION.

WE APPRECIATE YOUR INVITATION TO TESTIFY AT THIS HEARING AND TO GIVE YOU OUR VIEWS CONCERNING THE DEPARTMENT OF ENERGY'S ENRICHMENT PROGRAM. WE WILL ADDRESS THE QUESTIONS IN YOUR LETTER OF INVITATION AS WELL AS THE NEED WE PERCEIVE FOR EARLY DEPLOYMENT OF NEW ENRICHMENT TECHNOLOGY.

WE ARE CONVINCED A STRONG, COST-COMPETITIVE, ASSURED DOMESTIC URANIUM ENRICHMENT SERVICE IS VITAL TO UNITED STATES' SECURITY AND NATIONAL INTERESTS. IT REDUCES DEPENDENCE ON FOREIGN ENERGY SOURCES, PROVIDES COMPETITIVELY PRICED FUEL TO U.S. UTILITIES, PROVIDES THOUSANDS OF JOBS, IMPROVES OUR BALANCE OF TRADE AND, TO THE EXTENT IT SERVES FOREIGN CUSTOMERS, INCREASES THE U.S. ABILITY TO STABILIZE WORLDWIDE NUCLEAR AFFAIRS.

FOR MANY YEARS, THE U.S. URANIUM ENRICHMENT ENTERPRISE HAD LITTLE COMPETITION AND ENJOYED THE DOMINANT POSITION IN THE DOMESTIC, INDEED THE WORLD MARKET, NOT UNLIKE THE U.S. AUTO AND STEEL INDUSTRIES.

AND LIKE THE AUTO AND STEEL INDUSTRIES, FOREIGN COMPETITION HAS GAINED A MAJOR SHARE OF THE ENRICHMENT MARKET. TIMELY, DECISIVE ACTION IS REQUIRED NOW TO RESTORE THE STRENGTH OF THE U.S. ENRICHMENT ENTERPRISE.

WE APPLAUD DOE ACTIONS TO OPERATE THE ENRICHMENT ENTERPRISE IN ACCORDANCE WITH SOUND BUSINESS PRACTICES, TO LOWER COST AND TO BE MORE RESPONSIVE TO ITS CUSTOMERS' NEEDS.

DOE'S RECENT INITIATIVE IN OFFERING AND NEGOTIATING NEW UTILITY CONTRACTS WAS BOTH TIMELY AND EFFECTIVE. THIS IS AN IMPORTANT FIRST STEP IN MAINTAINING A HEALTHY U.S. ENRICHMENT ENTERPRISE AND DEFEATING THE INROADS OF FOREIGN COMPETITION.

A LARGE SEGMENT OF THE MARKET REMAINS UNCOMMITTED, HOWEVER, AND DOE MUST AGGRESSIVELY PURSUE THIS MARKET WHILE CONTINUING TO MEET THE NEEDS OF ITS PRESENT CUSTOMERS, ELSE THEY TOO WILL BE LOST.

WE ARE CONCERNED THAT, BY DELAYING THE DEPLOYMENT OF NEW, MORE COST-EFFECTIVE, LESS ENERGY CONSUMING ENRICHMENT TECHNOLOGY, DOE WILL CONTINUE TO LOSE MARKET SHARE, BOTH DOMESTIC AND FOREIGN. THE U.S. WILL BECOME MORE DEPENDENT ON FOREIGN ENERGY SOURCES, JOBS WILL BE LOST AND OUR INFLUENCE IN WORLD NUCLEAR AFFAIRS WILL LESSEN.

AS IN THE PRIVATE SECTOR, TIMING IS VERY IMPORTANT IN THE WORLD MARKET FOR URANIUM ENRICHMENT. FURTHER DELAY IN THE DEPLOYMENT OF CENTRIFUGE TECHNOLOGY IS UNWISE AND WILL ALLOW FOREIGN COMPETITION TO MOVE FARTHER AHEAD IN THE MARKET. WAITING FOR SOMETHING NEW FROM THE LABORATORY CAN BE A FATAL MISTAKE.

RELIANCE ON THE LONG-RANGE, COMPETITIVE COST OF GASEOUS DIFFUSION SWU'S IN THE MEANTIME IS VERY RISKY. THE GASEOUS DIFFUSION PLANTS HAVE MADE VERY COMMENDABLE REDUCTIONS IN OPERATING COSTS. THEIR PROJECTIONS OF FUTURE COSTS, HOWEVER, ARE HEAVILY DEPENDENT ON THE PRICE OF ELECTRIC POWER THAT IS SUBJECT TO UNFORESEEN, RAPID COST INCREASES DUE TO ENERGY SHORTAGES, INCREASES IN THE COST OF FUEL, OR UNSTABLE WORLD POLITICAL AND ECONOMIC CONDITIONS.

AT GOODYEAR, WE WERE FACED WITH A SIMILAR MARKETPLACE DECISION IN THE 1970'S. GOODYEAR INVESTED HEAVILY IN NEW TIRE MANUFACTURING TECHNOLOGY AT A TIME WHEN THE INDUSTRY HAD EXCESS CAPACITY, THERE WERE DEFINITE DOWNWARD TRENDS IN THE U.S. AUTO TIRE MARKET, AND THE WORLD MARKET WAS LOW GROWTH.

GOODYEAR BORROWED HEAVILY IN ORDER TO DEPLOY NEW TECHNOLOGY UNDER THESE ADVERSE CONDITIONS. SUBSEQUENT EVENTS HAVE CONFIRMED THE WISDOM OF THIS DECISION. GOODYEAR OBTAINED A MAJOR ADVANTAGE OVER ITS COMPETITORS BY SEIZING THE OPPORTUNITY AT THE RIGHT TIME AND DEPLOYING THE LATEST PRODUCTION TECHNOLOGY. GOODYEAR'S PROFIT IN 1984 WAS THE HIGHEST IN ITS HISTORY, MARKET SHARE HAS INCREASED AND PLANTS ARE RUNNING NEAR CAPACITY.

WE REALIZE THAT UNDER ZERO APPROPRIATIONS LIMITATIONS WITH HIGH GOVERNMENT DEFICITS, DOE FINDS IT DIFFICULT TO CARRY FORWARD THE DEPLOYMENT OF THE ADVANCED GAS CENTRIFUGE AT A PACE THAT IS THE MOST COST-EFFECTIVE, A PACE THAT WOULD ALSO PUT THE U.S. IN THE BEST COMPETITIVE POSITION. HOWEVER, DOE AND CONGRESS SHOULD LOOK AT THE VALUE OF OPERATING THE ENRICHMENT PROGRAM AS A BUSINESS. SOME ADDED EXPENDITURES IN THE NEAR-TERM WILL SAVE DOLLARS IN THE FUTURE AND SEIZING THE OPPORTUNITY NOW WILL DEFEAT FOREIGN COMPETITION.

NO WELL-MANAGED BUSINESS WOULD UNDERTAKE CONSTRUCTION OF A MAJOR, NEW PLANT FOR WHICH THE COMPLETION SCHEDULE WAS ENTIRELY DEPENDENT ON ANNUAL CASH FLOW. IT IS FUNDAMENTAL THAT THE EARLIER A NEW PLANT STARTS PRODUCING PRODUCT, THE MORE COST-EFFECTIVE IT WILL BE.

WE AT GOODYEAR AEROSPACE ARE CONVINCED THE TECHNICAL DEVELOPMENT REQUIREMENTS OF THE ADVANCED GAS CENTRIFUGE (AGC) ARE REASONABLE AND MANAGEABLE AND THE AGC MACHINES SHOULD BE PUT INTO PRODUCTION WITHOUT DELAY. BY SO DOING, SERIOUS AND COSTLY PRODUCTION INTERRUPTIONS ARE AVOIDED -- THE LAY-OFF OF TRAINED EMPLOYEES AND COSTS OF REHIRING, RETRAINING AND RECLEARING NEW EMPLOYEES IS AVOIDED. DELAYS IN THE DEPLOYMENT OF THE ADVANCED CENTRIFUGE CREATES THE PERCEPTION IN THE MINDS OF DOE'S UTILITY CUSTOMERS OF AGC BEING AS RISKY AS AVLIS AND CREATES DOUBTS DOE WILL EVER DEPLOY MORE COST-EFFECTIVE TECHNOLOGY.

AGC IS BASED ON OVER 25 YEARS OF DEVELOPMENT AND A SOLID BASE OF PROVEN, FULL-SCALE OPERATIONS TECHNOLOGY. TEST RESULTS ON THE AGC PROGRAM IN THE PAST YEAR HAVE CONTINUED TO CONFIRM THE PROJECTED GAS DYNAMICS AND PERFORMANCE PROJECTIONS. FABRICATION EXPERIENCE HAS SIMILARLY CONFIRMED OUR ABILITY TO MANUFACTURE THE NEW, MORE COST-EFFECTIVE CENTRIFUGE MACHINES. OPERATING EXPERIENCE IN THE GCEP PLANT HAS BEEN OUTSTANDING AND HAS PROVEN THAT THE PLANT DESIGN AND THE PLANT CONTROL SYSTEMS ARE SOUND, SAFE, RELIABLE AND READY.

IN CONCLUSION, MADAM CHAIRMAN, LET ME ADDRESS THE QUESTIONS IN YOUR LETTER OF INVITATION--

TIMELY, AGGRESSIVE DEPLOYMENT OF THE ADVANCED CENTRIFUGE TECHNOLOGY MUST BEGIN IN FY-86, OR THE U.S. ENTERPRISE WILL CONTINUE TO LOSE MARKET TO FOREIGN COMPETITION, MARKET THAT MAY NEVER BE RECOVERED.

WE KNOW THE JAPANESE HAVE BEEN AGGRESSIVELY DEVELOPING CENTRIFUGE TECHNOLOGY AND ARE COMMITTED TO DEPLOY A CENTRIFUGE ENRICHMENT PLANT. WE KNOW URENCO IS CONSIDERING ACCELERATING THE PLANNED DOUBLING OF ITS ENRICHMENT CAPACITY. WE MUST NOT STAND BY AND ALLOW FOREIGN COMPETITION TO OVERRUN OUR DOMESTIC MARKET AS WELL AS THE INTERNATIONAL MARKET.

THE ADVANCED CENTRIFUGE IS READY FOR DEPLOYMENT. IN OUR CANDID ASSESSMENT, THE AVLIS TECHNOLOGY SHOWS PROMISE FOR THE FUTURE BUT IS STILL IN THE LABORATORY STAGE OF DEVELOPMENT. CENTRIFUGES, HOWEVER, ARE RUNNING NOW IN THE GCEP AT PORTSMOUTH, OHIO. THERE ARE MAJOR UNCERTAINTIES IN THE AVLIS TECHNOLOGY, AND IN THE AVLIS CAPITAL AND OPERATING COSTS THAT WILL REQUIRE YEARS TO RESOLVE. IN CONTRAST, THREE MANUFACTURERS HAVE PRODUCED 1,500 P1 CENTRIFUGES, OVER 900 OF WHICH ARE INSTALLED AND READY TO OPERATE IN GCEP, AND THE U.S. GOVERNMENT HAS INVESTED $2.6 BILLION IN GCEP, A PLANT THAT IS ON SCHEDULE AND WITHIN BUDGET. THIS EXPERIENCE GIVES US CONFIDENCE IN THE CAPITAL, OPERATING AND SWU COSTS FOR GCEP WITH ADVANCED CENTRIFUGES.

IF I MAY QUOTE FROM THE FEBRUARY 11, 1985 ISSUE OF FORBES MAGAZINE -- "SOONER OR LATER -- IN THE MID-NINETIES, IN THE LATE EIGHTIES EVEN -- THE U.S. WILL ALMOST CERTAINLY NEED TO BEGIN PLANNING LARGE CENTRAL POWER STATIONS AGAIN." "BUT IF NOT COAL, AND IF NOT OIL AND GAS, THEN WHAT?" "EVERYWHERE ELSE IN THE WORLD THE ANSWER IS NUCLEAR." "...ELSEWHERE IN THE WORLD (NUCLEAR) IS A LOW-COST, RELIABLE, ENVIRONMENTALLY IMPECCABLE FORM OF ENERGY..."

AND SO IT MUST BE IN THE U.S.

WE BELIEVE THE FY-1986 BUDGET FOR GCEP, INCLUDING R&D, MUST BE AT LEAST $460 MILLION AND FUTURE BUDGETS SHOULD GRADUALLY INCREASE TO A PEAK OF ABOUT $675 MILLION IN 1989. THESE BUDGET LEVELS ARE NEEDED FOR TIMELY DEPLOYMENT OF THE ADVANCED CENTRIFUGE IN ORDER TO PROVIDE AN AGGRESSIVE RESPONSE TO FOREIGN COMPETITION AND TO ASSURE THE CONTINUED STRENGTH OF THE U.S. ENRICHMENT ENTERPRISE. IF NECESSARY, SOME MEANS MUST BE FOUND TO RELIEVE DOE OF THE CONSTRAINT FOR NET ZERO APPROPRIATIONS.

WE ALSO RECOMMEND AVLIS RESEARCH AND DEVELOPMENT BE CONTINUED AT AN AFFORDABLE LEVEL AND A REALISTIC PACE FOR POSSIBLE DEPLOYMENT IN THE NEXT CENTURY, IF AVLIS EVENTUALLY PROVES TO HAVE ECONOMIC VALUE.

DECISIVE, FAR-SIGHTED ACTION BY DOE AND CONGRESS IS REQUIRED NOW TO:

- PROTECT OUR NATIONAL SECURITY AND INTERESTS.
- PROVIDE A LOW-COST, ASSURED SOURCE OF DOMESTIC URANIUM ENRICHMENT.
- DEFEAT THE INROADS OF FOREIGN COMPETITION.
- RECOVER THE $2.6 BILLION OF TAXPAYERS' FUNDS ALREADY INVESTED IN GCEP.

WE URGE CONGRESS TO PROVIDE AT LEAST $450 MILLION FOR GCEP IN FY-1986 IN ORDER TO START AGGRESSIVE DEPLOYMENT OF THE ADVANCED GAS CENTRIFUGE AT A TIMELY AND COST-EFFECTIVE PACE. ANYTHING LESS WILL RISK THE FURTHER SERIOUS INROADS OF FOREIGN COMPETITION IN BOTH THE DOMESTIC AND FOREIGN MARKETS AND WILL SIGNIFICANTLY INCREASE THE CAPITAL COSTS OF GCEP.

Mrs. LLOYD. Thank you very much.

The committee will stand in recess for this vote.

[Recess taken.]

Mrs. LLOYD. The subcommittee will resume its hearing.

Mr. Rowan, we welcome your testimony. Please proceed.

STATEMENT OF CHARLES J. ROWAN, DIRECTOR, ENRICHMENT SYSTEMS, AIRESEARCH MANUFACTURING CO.

Mr. ROWAN. Thank you, Madam Chairman.

I am Charles Rowan, director of enrichment systems for Airesearch Manufacturing Co., which is a division of the Garrett Corp., and that in turn is one of the Signal Companies. With me today are Jeff Eagleson from our congressional liaison office in Washington and Larry Huppert from our Los Angeles operations.

Garrett has been an active participant in DOE's uranium enrichment enterprise since 1961. We are there primarily because of having won competitions in which a principal evaluation element was our expertise in high-speed rotating equipment, both in the design and manufacture of it. That has carried through, of course, into the Gas Centrifuge Program. We currently have about 700 people working on the centrifuge, down from nearly 1,000 a year ago, and the work is carried out in Torrance, CA and Sandusky, OH, with site support people in Oak Ridge and Portsmouth, OH.

Your letter of February 7 invited Airesearch to testify on four topics: DOE's proposed Gas Centrifuge Enrichment Program for 1986; second, their program plan for the out-years; third, you requested our assessment of the minimum out-year expenditures for gas centrifuge procurement and development, whether or not AGC is selected for deployment; and, fourth, you asked our candid assessment of the AVLIS process. I think before we address these issues, and taking into account some very dramatic changes that have taken place over the past year, I would like to comment about two or three of those in particular.

Of great signficance to us is the fact that the DOE has made an initial implementation of their market-driven strategy, and it has been characterized most notably by the new U.S. SWU contract, with a very broad acceptance of this contract having been achieved from the customer utilities. The next major event is that, as a result of that action, the DOE has been able to firm up its estimation of the SWU revenue stream; and at the same time, as you know, they had in place a substantial planned expenditure for GCEP construction and advanced technology development and deployment and it resulted in—unless it were attenuated, in a revenue shortfall over the next 3 to 5 fiscal years. In concert with these two major events, the DOE initiated a very comprehensive peer review process to effect the technology selection as between AGC and AVLIS.

All of these events are occurring coincident with a sizable Federal deficit overall. There is a strong atmosphere prevalent of fiscal restraint, as you well know, within the administration, the Congress, and the public at large.

This combination of events caused DOE just 2½ months ago to evaluate a major restructing of GCEP and AGC programs with the

Centrifuge Program team led by Ken Sommerfeld at Martin Marietta. DOE has endorsed a deployment plan which reduces near-term revenue outlays, stretches out the program, and produces a production interruption on centrifuge of about 2 years at a minimum. It also substantially reduces centrifuge program jobs by the end of fiscal year 1985, and we have been significantly impacted by this turn of events. We have dropped from about 1,000 jobs in centrifuge a year ago to 700 today. I am reducing people in the program at the rate equivalent of one trained person per day in order to get to the necessary goal of less than 500 people on the program before the end of fiscal 1985, even if AGC is the selected technology in May.

Notwithstanding these considerable challenges that I have noted, the past year has produced a number of very positive accomplishments in the development program on AGC. We have had some minor setbacks but the achievements overshadow those greatly.

At Garrett we have successful balanced rotors through the required dynamic criticals for the AGC, and that is a major milestone in demonstrating dynamic performance of the machine. We have run machines up to 99 percent of the targeted AGC design speed. I couldn't possibly overstress, Madam Chairman, the importance of these two accomplishments in proving out the feasibility of a 600-SWU advanced AGC in the very near future.

Concurrently, the new advanced material used in rotor construction is proving to be even better in application than we had ever expected. We have been able to demonstrate that our dynamic control concepts work even more effectively than we had forecast, and so we have a very high degree of confidence that all of our development goals for advanced gas centrifuge will be achieved timely.

I want to tell you just for a moment about a proposal that we had submitted to DOE on the 1st of February. On that date the Garrett Corp. made a proposal to the Department of Energy which we think provided very concrete, specific, pointed evidence of our confidence in the Advanced Gas Centrifuge Program as well as in the future of the uranium enrichment enterprise itself. This proposal basically, confirmed formally in writing a week later, embodied a low-cost, low-risk AGC predeployment plan that would be contracted for on a cost incentive basis, and it was coupled to the offer of a firm, fixed-price AGC Production Program for which Garrett offered to accept deferred payment from DOE as a step toward easing their projected revenue shortfall problem.

There are a number of details to this proposal that are under evaluation in DOE, but prominent among the features of the program was the plan for a very early, aggressive reliability development and growth program that was coupled to unique incentivization provisions. The composite effect of the whole plan we thought offered DOE a very high degree of risk mitigation and very rapid risk closure for advanced gas centrifuge technology. They would get far more protection than their current program structure provides, while we in turn would be financially motivated to maximize machine performance and expedite schedule completion. We think that the plan could help to achieve rapid plant modernization and the attendant improvements in enrichment service pricing structure so necessary to implement the DOE's very well conceived market driven strategy and do it at a substantially lower cost.

We recognize that the fundamental DOE requirement exists for competitively procuring the bulk of AGC production. Our plan provided for the furnishing of a complete procurement package, including build-to-print drawings and specifications to accomplish this very important technology transfer activity.

Our proposal indicates, in my opinion, that significant improvements can be made by restructuring the program to decrease costs and to accelerate the availability of the set V machine at less risk to the Government.

Let me go to your specific questions, if I may, the first of which had to do with our comments on DOE's proposed Gas Centrifuge Enrichment Program for 1986. In light of the May 1985 technology selection decision between AGC and AVLIS, the DOE 1986 budget request submitted to Congress is designed to accommodate a range of choices related to that technology decision. As a consequence, it is understandably nonspecific with respect to funding details on GCEP and AGC, particularly in the context of our understanding of the new DOE/Martin Marietta deployment plan. It therefore reflects the transition being experienced in the overall uranium enrichment enterprise, and so the role of the centrifuge in the enterprise will not be firmly established until these decisions are forthcoming from DOE in May.

We acknowledge that the budget request provides for continuation of centrifuge development and reliability testing but, by the same token, it is virtually certain that there will be a substantial production interrupt, since set III production will be completed in February 1986, at Garrett under the DOE plan, and I think that's true of the other manufacturers. As such, we feel that it will produce a destabilization of the centrifuge skilled human resource base, assuming even that AGC does win in May. It's obvious that the extent of contractors and that the extent of work performed by each must change, and yet the specifics on all these matters will hinge on the May 1985 selection and DOE's subsequent deployment decision.

I would like to address your question on DOE's program plan for the outyears. Again, in that period of time, reading the budget document, the situation is unclear until that May 1985 production plan is completed, since the DOE budget document tends to dwell almost exclusively on the near term. I think their plan places a discernible major reliance in the outyears on continued operation of aging gaseous diffusion plants, perhaps for at least another one or two decades, and it therefore assumes that a minimal increase in electric power costs for these very energy-intensive facilities will prevail.

There should not be undue reliance on the possible combination of aging gaseous diffusion plants and the substantially unproven AVLIS process to deliver the enterprise enrichment projections in the outyears. As an example, SWU cost of the advanced technology is now to be compared to the marginal cost of enrichment from the diffusion plants without, we believe, due consideration having been given to potentially major diffusion plant cost increases as energy costs rise and inevitable wear out failures occur in these 40-year-old facilities.

You asked a question concerning our comment on the minimum out-year expenditures for gas centrifuge procurement and development, whether or not AGC is selected. Well, first of all, if AGC is not selected in May there is really little or no incentive for a private centrifuge developer and manufacturer like Garrett to continue with an involvement in the program. The fairly minimal funding which will be provided to keep the AGC technology in a backup mode under that condition would be inadequate to do anything more than support the GOCO, Martin Marietta.

Profit oriented commercial companies, particularly those in high-technology industries where human and capital resources are typically if not exclusively applied to success oriented business opportunities, such companies would be little inclined to continue in such an environment. Moreover, most of the talented, achievement oriented engineers and professionals that make up our work force tend to avoid such backup programs in preference to staying at the leading edge of technology in our company.

So we believe that the Garrett proposal that we have submitted to DOE represents an efficient and low-cost approach to AGC pre-deployment planning and subsequent AGC fixed-price production for both near term and the outyears.

You asked a question concerning our candid assessment of the AVLIS process. We are constrained, as the other speakers have noted, from a detailed response to this request, both by virtue of the ongoing nature of the peer review process and the fact that we have all signed nondisclosure agreements while that very vital work is going on, so I can only offer observations that are not technically specific as it is continuing to be evaluated in PEB. Our observations are necessarily generic and are influenced strongly by our historical experience in Garrett as well as the Signal family of companies, and that organization encompasses a highly diversified set of high-technology product lines, engineering, construction, and plant operation.

So, with that caveat in mind, the following general comments are offered to you: AVLIS is still basically a research project. Livermore has been involved in R&D on it for 12 or 13 years now and has expended about $350 million in its uranium applications alone, not taking into account its funded work in plutonium. In spite of this, I don't believe they have yet made significant end-to-end full-scale integrated systems experiments that demonstrate the actual separation of uranium-235 from 238 in quantity. In fact, our understanding is that, barring any very recent successful system tests, they have really produced substantially less than one SWU.

Based on their requests earlier this year, at least, they would require an additional $600 million or so of R&D funding through 1991, exclusive of capital expenditures for engineering and construction.

Mrs. LLOYD. Excuse me, Mr. Rowan, but in fairness would you wrap up your statement?

Mr. ROWAN. Surely.

Mrs. LLOYD. Thank you.

Mr. ROWAN. On that basis, Madam Chairman, I think you will be able to read these detailed comments at your leisure later on.

In summary, AVLIS is basically, in our opinion, placing an undue dependence on modeling rather than experimentation for its advocacy of selection in May. From our standpoint, that's something we would never do in private business, make a go-forward decision on such minimal testing.

In contrast with that, the AGC technology and centrifuge technology has a very large base of demonstrated capability, nearly 200,000 SWU produced in production-type machines as well as development, and a very large data and cost history base on plant-scale operations to base judgments upon for future deployment.

So in conclusion I would like to say that we want to commend DOE for what we think is a magnificent job that they have done this past year in initiating a market-driven strategy. We think centrifuge technology is at a crossroads, and the administration and the Congress decisionmaking in May and later this year I think will determine the future of enrichment in the country. So on that basis we ask you to make a very critical review of all the factors involved in it.

Thank you.

[The prepared statement of Mr. Rowan follows:]

PREPARED STATEMENT OF CHARLES ROWAN

MADAM CHAIRMAN AND MEMBERS OF THIS SUBCOMMITTEE, I AM CHARLES ROWAN, DIRECTOR OF ENRICHMENT SYSTEMS FOR AIRESEARCH MANUFACTURING COMPANY, A DIVISION OF THE GARRETT CORPORATION, ONE OF THE SIGNAL COMPANIES. I AM ACCOMPANIED TODAY BY MR. JEFFREY P. EAGLESON OF GARRETT'S WASHINGTON, D.C. CONGRESSIONAL LIAISON OFFICE.

INTRODUCTION

GARRETT HAS BEEN AN ACTIVE PARTICIPANT IN DOE'S URANIUM ENRICHMENT ENTERPRISE, SPECIFICALLY IN THE DEVELOPMENT AND SUBSEQUENT PRODUCTION OF GAS CENTRIFUGES, SINCE 1961. AS AN ACKNOWLEDGED AND EXPERIENCED HIGH-TECHNOLOGY COMPANY AND A LEADER IN THE ENGINEERING AND MANUFACTURING OF HIGH-SPEED ROTATING EQUIPMENT, WE ARE UNIQUELY QUALIFIED TO PARTICIPATE IN THE GAS CENTRIFUGE PROGRAM. WE CURRENTLY EMPLOY APPROXIMATELY 700 PEOPLE IN THIS ACTIVITY, DOWN FROM NEARLY 1000 PEOPLE A YEAR AGO. THIS WORK IS CARRIED OUT AT OUR TORRANCE, CALIFORNIA AND SANDUSKY, OHIO FACILITIES, AND BY SITE SUPPORT PERSONNEL AT OAK RIDGE, TENNESSEE AND PORTSMOUTH, OHIO.

YOUR LETTER OF FEBRUARY 7, 1985 INVITING ME TO TESTIFY AT THESE HEARINGS REQUESTED OUR COMMENTS ON (a) DOE'S PROPOSED GAS CENTRIFUGE ENRICHMENT PROGRAM FOR FY 1986, (b) THEIR PROGRAM PLAN FOR THE OUT YEARS, (c) OUR ASSESSMENT OF MINIMUM OUT-YEAR EXPENDITURES FOR GAS CENTRIFUGE PROCUREMENT AND DEVELOPMENT, WHETHER OR NOT THE ADVANCED GAS CENTRIFUGE (AGC) IS SELECTED FOR EVENTUAL DEPLOYMENT, AND (d) OUR CANDID ASSESSMENT OF THE ATOMIC VAPOR LASER ISOTOPE SEPARATION (AVLIS) PROCESS. BEFORE

ADDRESSING THESE ISSUES AND IN CONSIDERATION OF THE VERY DRAMATIC CHANGES WHICH HAVE OCCURRED WITHIN DOE'S URANIUM ENRICHMENT ENTERPRISE OVER THE PAST YEAR, SEVERAL PREPARATORY COMMENTS ARE IN ORDER.

RECENT BACKGROUND

IN THE PAST YEAR THE FOLLOWING SIGNIFICANT EVENTS HAVE TAKEN PLACE:

- INITIAL IMPLEMENTATION OF THE DOE MARKET-DRIVEN STRATEGY MOST NOTABLY CHARACTERIZED BY THE NEW UTILITY SERVICES CONTRACT AND A BROAD ACCEPTANCE OF THIS CONTRACT BY THE CUSTOMER UTILITIES.
- FIRMING UP OF THE SWU REVENUE STREAM FROM A COMPILATION OF THE RESULTS OF CONTRACT CONVERSION AND A REDUCTION IN FORECASTED REVENUES, ACCOMPANIED BY SUBSTANTIAL PLANNED EXPENDITURES FOR GCEP CONSTRUCTION AND ADVANCED TECHNOLOGY DEVELOPMENT AND DEPLOYMENT, RESULTING IN DOE FORECASTING A SIGNIFICANT REVENUE SHORTFALL OVER THE NEXT THREE TO FIVE FISCAL YEARS.
- INITIATION OF A COMPREHENSIVE "PEER REVIEW" PROCESS TO IMPLEMENT THE AGC VS. AVLIS TECHNOLOGY SELECTION.

THESE EVENTS ARE, OF COURSE, OCCURRING COINCIDENT WITH THE EXISTENCE AND FUTURE PROJECTION OF SIZABLE FEDERAL DEFICITS, CREATING A STRONG ATMOSPHERE OF FISCAL RESTRAINT WITHIN THE ADMINISTRATION, THE CONGRESS AND WITH THE PUBLIC AT LARGE.

THIS COMBINATION OF EVENTS CAUSED DOE, JUST TWO-AND-A-HALF MONTHS AGO, TO EVALUATE A MAJOR RESTRUCTURING OF THE GCEP AND AGC PROGRAMS WITH THE CENTRIFUGE PROGRAM TEAM (CPT), LED BY MARTIN MARIETTA ENERGY SYSTEMS, INC. DOE HAS ENDORSED A DEPLOYMENT PLAN WHICH REDUCES NEAR TERM REVENUE OUTLAYS, STRETCHES OUT THE PROGRAM, AND PRODUCES A CENTRIFUGE PRODUCTION INTERRUPT OF ONE-AND-A-HALF TO TWO YEARS AS A MINIMUM. IT ALSO SUBSTANTIALLY REDUCES CENTRIFUGE PROGRAM JOBS BY THE END OF FY 1985. GARRETT, OF COURSE, HAS BEEN SIGNIFICANTLY IMPACTED BY THIS TURN OF EVENTS. AS I MENTIONED EARLIER WE HAVE GONE FROM APPROXIMATELY ,000 JOBS A YEAR AGO TO 700 PRESENTLY. EVEN ASSUMING THAT WE WIN THE AGC VS. AVLIS TECHNOLOGY SELECTION IN MAY OF THIS YEAR, WE EXPECT TO EMPLOY LESS THAN 500 PEOPLE ON THE PROGRAM BEFORE THE END OF FY 1985.

AGC DEVELOPMENT PROGRESS

IN SPITE OF THESE CHALLENGES, THE PAST YEAR HAS PRODUCED A NUMBER OF VERY POSITIVE ACCOMPLISHMENTS IN THE AGC DEVELOPMENT PROGRAM. WHILE SOME MINOR SETBACKS HAVE OCCURRED, THE FOLLOWING NOTABLE ACHIEVEMENTS HAVE BEEN MADE BY GARRETT. WE HAVE SUCCESSFULLY BALANCED ROTORS THROUGH THE REQUIRED DYNAMIC CRITICALS, A MAJOR MILESTONE IN DEMONSTRATING DYNAMIC PERFORMANCE. WE HAVE RUN MACHINES UP TO 99% OF THE TARGETED AGC DESIGN SPEED. WE CANNOT OVERSTRESS THE IMPORTANCE OF THESE TWO ACCOMPLISHMENTS IN PROVING THE FEASIBILITY OF A 600 SWU ADVANCED GAS CENTRIFUGE

IN THE VERY NEAR FUTURE. THE NEW ADVANCED MATERIAL USED IN ROTOR CONSTRUCTION IS PROVING TO BE EVEN BETTER IN APPLICATION THAN WE HAD EXPECTED. WE HAVE DEMONSTRATED THAT OUR DYNAMIC CONTROL CONCEPTS WORK EVEN MORE EFFECTIVELY THAN WE HAD FORECAST, GIVING US HIGH CONFIDENCE THAT ALL OF OUR DEVELOPMENT GOALS WILL BE ACHIEVED.

A GARRETT AGC PROPOSAL

ON THE FIRST OF FEBRUARY, THE GARRETT CORPORATION MADE A PROPOSAL TO DOE WHICH PROVIDED CONCRETE AND POINTED EVIDENCE OF OUR CONFIDENCE IN THE ADVANCED GAS CENTRIFUGE PROGRAM AS WELL AS IN THE FUTURE OF THE URANIUM ENRICHMENT ENTERPRISE ITSELF. THIS PROPOSAL, CONFIRMED FORMALLY IN WRITING ON FEBRUARY 6th, EMBODIES BOTH (1) A LOW COST, LOW RISK, AGC PRE-DEPLOYMENT PLAN TO BE CONTRACTED FOR ON A COST-INCENTIVE BASIS, AND (2) A FIRM FIXED-PRICE AGC PRODUCTION PROGRAM FOR WHICH GARRETT OFFERRED TO ACCEPT DEFERRED-PAYMENT FROM DOE AS A STEP TOWARD EASING DOE'S PROJECTED REVENUE SHORTFALL PROBLEM. WE BELIEVE THAT THE DETAILED FEATURES OF THIS PROPOSAL, INCLUDING AN EARLY, AGGRESSIVE RELIABILITY DEVELOPMENT PROGRAM AND UNIQUE INCENTIVIZATION PROVISIONS, GUARANTEE DOE A HIGH DEGREE OF RISK MITIGATION WITH RAPID RISK CLOSURE. DOE WOULD RECEIVE FAR MORE PROTECTION THAN UNDER THEIR CURRENT PROGRAM STRUCTURE, WHILE GARRETT WOULD BE FINANCIALLY MOTIVATED TO MAXIMIZE MACHINE PERFORMANCE AND EXPEDITE SCHEDULE COMPLETION. WE BELIEVE THAT OUR PROPOSED PLAN COULD ACHIEVE RAPID PLANT MODERNIZATION AND THE ATTENDANT

IMPROVEMENT IN THE ENRICHMENT SERVICES PRICING STRUCTURE NECESSARY TO IMPLEMENT DOE'S WELL-CONCEIVED MARKET-DRIVEN STRATEGY AT A SUBSTANTIALLY LOWER COST. RECOGNIZING THE FUNDAMENTAL DOE REQUIREMENT FOR COMPETITIVELY PROCURING THE BULK OF AGC PRODUCTION, OUR PLAN ALSO WOULD PROVIDE A COMPLETE PROCUREMENT PACKAGE, INCLUDING BUILD-TO-PRINT DRAWINGS AND SPECIFICATIONS, TO ACCOMPLISH TECHNOLOGY TRANSFER.

OUR PROPOSAL INDICATES, IN OUR OPINION, THAT SIGNIFICANT IMPROVEMENTS CAN BE MADE BY RESTRUCTURING THE PROGRAM TO DECREASE COSTS AND ACCELERATE AVAILABILITY OF THE SET V MACHINE AT LESS RISK TO THE GOVERNMENT.

LET ME NOW SPECIFICALLY ADDRESS THE QUESTIONS RAISED IN YOUR FEBRUARY 8, 1985 LETTER OF INVITATION.

COMMENTS ON DOE'S PROPOSED GAS CENTRIFUGE ENRICHMENT PROGRAM FOR FY 1986

IN VIEW OF THE FORTHCOMING MAY 1985 TECHNOLOGY SELECTION, I.E., THE DECISION BETWEEN AGC AND AVLIS, DOE'S FY 1986 BUDGET REQUEST SUBMITTED TO CONGRESS ON FEBRUARY FIRST IS DESIGNED TO ACCOMMODATE A RANGE OF CHOICES RELATED TO THAT TECHNOLOGY DECISION. IT IS UNDERSTANDABLY NON-SPECIFIC WITH RESPECT TO FUNDING DETAILS ON GCEP AND AGC, PARTICULARLY IN THE CONTEXT OF OUR DETAILED KNOWLEDGE OF THE NEW DOE/MARTIN MARIETTA DEPLOYMENT PLAN. IT REFLECTS THE TRANSITION BEING EXPERIENCED IN THE OVERALL URANIUM ENRICHMENT ENTERPRISE. THUS, THE ROLE OF THE CENTRIFUGE IN THE ENTERPRISE WILL NOT BE FIRMLY ESTABLISHED

UNTIL THE PROGRAM DECISIONS ARE MADE IN MAY. WE ACKNOWLEDGE THAT THE BUDGET REQUEST PROVIDES FOR CONTINUATION OF CENTRIFUGE DEVELOPMENT AND RELIABILITY TESTING, BUT BY THE SAME TOKEN IT IS VIRTUALLY CERTAIN THAT THERE WILL BE A SUBSTANTIAL PRODUCTION INTERRUPT SINCE SET III PRODUCTION WILL BE COMPLETED IN FEBRUARY 1986. AS SUCH, WE FEEL THAT IT WILL PRODUCE A DESTABILIZATION OF THE CENTRIFUGE SKILLED HUMAN RESOURCE BASE, ASSUMING EVEN THAT AGC DOES WIN IN MAY. IT IS OBVIOUS THAT THE NUMBER OF CONTRACTORS AND THE EXTENT OF WORK PERFORMED BY EACH MUST CHANGE AND YET THE SPECIFICS WILL ALL HINGE ON THE MAY 1985 SELECTION AND SUBSEQUENT DEPLOYMENT DECISIONS. AS I AM SURE YOU ARE AWARE, DOE PLANS TO PROVIDE ADDITIONAL DETAIL ON THEIR FY 1986 BUDGET REQUEST AT THAT TIME.

DOE'S PROGRAM PLAN FOR THE OUT YEARS

WITH RESPECT TO THE POST-FY 1986 TIME PERIOD, THE SITUATION IS AGAIN UNCLEAR UNTIL THE MAY 1985 PRODUCTION PLAN IS COMPLETED, SINCE THE DOE BUDGET DOCUMENT DWELLS ALMOST EXCLUSIVELY ON THE NEAR TERM. THEIR PLAN DOES, HOWEVER, PLACE DISCERNIBLE MAJOR RELIANCE IN THE OUT YEARS ON CONTINUED OPERATION OF THE AGING GASEOUS DIFFUSION PLANTS (GDP'S) FOR AT LEAST ANOTHER ONE OR TWO DECADES AND, THEREFORE, ASSUMES A MINIMAL INCREASE IN ELECTRIC POWER COSTS FOR THESE VERY ENERGY-INTENSIVE FACILITIES, IF SWU PRICES ARE TO REMAIN COMPETITIVE IN THE WORLD MARKETPLACE. THERE SHOULD NOT BE UNDUE RELIANCE ON THE POSSIBLE COMBINATION OF THE GASEOUS DIFFUSION PLANTS AND THE SUBSTANTIALLY UNPROVEN

AVLIS PROCESS TO DELIVER THE ENTERPRISE ENRICHMENT PROJECTIONS IN THE OUT YEARS IN OUR OPINION. AS AN EXAMPLE, SWU COST OF THE ADVANCED TECHNOLOGY IS NOW TO BE COMPARED TO THE MARGINAL COST OF ENRICHMENT FROM THE GDP'S WITHOUT WE BELIEVE DUE CONSIDERATION TO POTENTIALLY MAJOR GDP COST INCREASES AS ENERGY COSTS RISE AND WEAR-OUT FAILURES INCREASE IN THESE 40-YEAR OLD FACILITIES.

MINIMUM OUT YEAR EXPENDITURES FOR GAS CENTRIFUGE PROCUREMENT AND DEVELOPMENT

IF AGC IS NOT SELECTED IN MAY, THERE REMAINS LITTLE OR NO INCENTIVE FOR A PRIVATE CENTRIFUGE DEVELOPER/MANUFACTURER LIKE GARRETT TO SEEK CONTINUED INVOLVEMENT IN THE PROGRAM. THE FAIRLY MINIMAL FUNDING WHICH WILL BE PROVIDED TO KEEP THE AGC TECHNOLOGY IN A BACKUP MODE WOULD BE INADEQUATE TO DO MORE THAN SUPPORT THE "GOCO" (GOVERNMENT-OWNED CONTRACTOR OPERATOR) MARTIN MARIETTA ENERGY SYSTEMS, INC. PROFIT-ORIENTED COMMERCIAL COMPANIES, PARTICULARLY IN THE HIGH-TECHNOLOGY INDUSTRIES WHERE HUMAN AND CAPITAL RESOURCES ARE TYPICALLY APPLIED ONLY TO SUCCESS-ORIENTED BUSINESS OPPORTUNITIES, WOULD BE LITTLE INCLINED TO CONTINUE IN SUCH AN ENVIRONMENT. MOREOVER, MOST TALENTED, ACHIEVEMENT-ORIENTED ENGINEERS AND PROFESSIONALS TEND TO AVOID SUCH "BACKUP" PROGRAMS IN PREFERENCE TO STAYING ON THE LEADING EDGE OF TECHNOLOGY.

WE BELIEVE THAT THE GARRETT PROPOSAL, DISCUSSED EARLIER, REPRESENTS AN EFFICIENT AND LOW COST APPROACH TO AGC PRE-DEPLOYMENT PLANNING AND SUBSEQUENT AGC FIXED-PRICE PRODUCTION FOR BOTH THE NEAR TERM AND THE OUT YEARS.

OUR CANDID ASSESSMENT OF THE AVLIS PROCESS

WE FIND OURSELVES CONSTRAINED FROM A DETAILED RESPONSE TO THIS REQUEST BY VIRTUE OF THE ONGOING NATURE OF THE PEER REVIEW PROCESS. THEREFORE, OUR OBSERVATIONS ARE NECESSARILY GENERIC IN NATURE, PRIMARILY BUSINESS-ORIENTED, AND INFLUENCED STRONGLY BY OUR HISTORICAL EXPERIENCE IN THE GARRETT CORPORATION AND WITHIN THE SIGNAL FAMILY OF COMPANIES WHICH ENCOMPASS HIGHLY DIVERSIFIED, HIGH-TECHNOLOGY PRODUCT LINES, ENGINEERING AND CONSTRUCTION, AS WELL AS PLANT OPERATIONS.

WITH THAT PREFACE, THE FOLLOWING ARE OUR GENERAL COMMENTS ON AVLIS.

- AVLIS IS STILL BASICALLY A RESEARCH PROJECT. LAWRENCE LIVERMORE NATIONAL LAB (LLNL) HAS BEEN INVOLVED IN AVLIS R&D FOR 12 YEARS AND HAS EXPENDED APPROXIMATELY 350 MILLION DOLLARS ON ITS URANIUM APPLICATION ALONE. IN SPITE OF THIS, THEY HAVE YET TO RUN SIGNIFICANT SCALE INTEGRATED EXPERIMENTS DEMONSTRATING ACTUAL SEPARATION OF U-235 FROM U-238. IN FACT, OUR UNDERSTANDING IS THAT, BARRING ANY VERY RECENT SUCCESSFUL SYSTEM TESTS, THEY HAVE STILL PRODUCED SUBSTANTIALLY LESS THAN ONE ACTUAL SEPARATIVE WORK UNIT (SWU). BASED ON LLNL'S REQUESTS OF EARLIER THIS YEAR, THEY WILL REQUIRE AN ADDITIONAL 600 MILLION DOLLARS OF R&D FUNDING THROUGH FY 1991, EXCLUSIVE OF CAPITAL EXPENDITURES FOR ENGINEERING AND CONSTRUCTION.

- THE DATA BASE ON AVLIS IS DERIVED LARGELY FROM SOPHISTICATED MATHEMATICAL MODELING WITH VERY FEW SUBSTANTIATING TESTS AT THE SYSTEMS LEVEL. THIS WOULD SEEM, TO AN INDUSTRIAL ORGANIZATION SUCH AS OURS, TO REPRESENT A POOR BASIS ON WHICH TO MAKE DECISIONS FOR MAJOR CAPITAL COMMITMENTS. THEREFORE, THE PROCESS SHOULD NOT BE SELECTED AS DOE'S ONLY ADVANCED TECHNOLOGY FOR THE FUTURE BASED ON THE LIMITED DATA AVAILABLE.
- AVLIS PLANT ENGINEERING AND CONSTRUCTION BEGINS LONG BEFORE FULL SCALE PROCESS DEMONSTRATIONS ARE CONDUCTED. LLNL SCHEDULES CALL FOR EXTENSIVE OVERLAP WITH THE ONGOING R&D EFFORT. IF THIS SITUATION IS MAINTAINED, IT COULD CAUSE MAJOR REQUIREMENTS FOR RE-ENGINEERING AND EXTENSIVE CONSTRUCTION MODIFICATIONS.
- THE EARLY R&D STATUS OF AVLIS IS A SUBSTANTIAL DETERRENT TO POTENTIAL PRIVATIZATION. FOR EXAMPLE, TO JUSTIFY PRIVATE INVESTMENT, THE INVOLVED FINANCIAL INSTITUTIONS WOULD HAVE A WHOLE NEW SPECTRUM OF RISK CONSIDERATIONS TO EVALUATE.

- AVLIS HAS EXTREMELY HIGH POTENTIAL FOR SCHEDULE DELAY AND MAJOR COST GROWTH, WE ESTIMATE A 5 TO 10-YEAR SCHEDULE SLIP AND A FACTOR OF FIVE OR MORE ON COST GROWTH.
- ON THESE BASES, WE CONSIDER AVLIS TO BE A VERY HIGH-RISK CHOICE FOR TECHNOLOGY SELECTION AND EARLY DEPLOYMENT.

BY CONTRAST, THE AGC IS CHARACTERIZED BY THE FOLLOWING:

- A MATURE STATE OF DEVELOPMENT WITH 165,000 SWU'S PRODUCED IN THE U.S. TO DATE FROM SET III AND EARLIER MACHINES AND MINIMAL FUTURE R&D REQUIRED
- A LARGE DATA BASE DERIVED FROM EXTENSIVE COMPONENT AND SYSTEM-LEVEL TESTING
- PLANT SCALE OPERATION HAS BEEN PROVEN ON THE SET III CENTRIFUGE AND IS APPLICABLE WITH MINOR MODIFICATION TO SET V AGC ON A CONSERVATIVE, SERIALLY-PLANNED SCHEDULE
- AGC HAS FULL COMPATIBILITY WITH THE ESTABLISHED NUCLEAR FUEL CYCLE AND AN INDUSTRIAL INFRASTRUCTURE ALREADY IN PLACE
- AGC IS A TECHNOLOGY WITH MINIMAL UNCERTAINTY IN DETAILED COST AND SCHEDULE ESTIMATES AND IS READY FOR POTENTIAL PRIVATIZATION.
- AGC IS THE MOST PRUDENT, LOW-RISK CHOICE FOR TECHNOLOGY SELECTION AND EARLY DEPLOYMENT

CONCLUDING COMMENTS

IN CONCLUSION, MADAM CHAIRMAN, GREAT PROGRESS HAS BEEN MADE ON AGC DEVELOPMENT THIS PAST YEAR. THE EASE WITH WHICH THE AGC CENTRIFUGE TRANSLATES TO OUR SET III MANUFACTURING PROCESS HAS EXCEEDED EVEN OUR EARLIER OPTIMISTIC PROJECTIONS. WHILE THE PEER REVIEW PROCESS AND ITS HUMAN RESOURCE REQUIREMENTS HAVE BEEN DEMANDING, WE ARE NONETHELESS VERY COMFORTABLE WITH THE DEVELOPMENT PROGRESS MADE TO DATE AND FULLY CONFIDENT THAT THE 600 SWU GOAL WILL BE ACHIEVED IN THE RELATIVELY NEAR TERM. OUR RECENT PROPOSAL TO DOE, AS DISCUSSED EARLIER, PROVIDES EVIDENCE OF THIS CONFIDENCE. WE BELIEVE THAT THE ADVANCED GAS CENTRIFUGE REPRESENTS THE WISEST, SAFEST, MOST ASSURED AND MOST ECONOMICAL TECHNOLOGY FOR URANIUM ENRICHMENT PLANT MODERNIZATION AND HAS THE ADDED ADVANTAGE OF AN EXISTING WELL-ESTABLISHED INDUSTRIAL INFRASTRUCTURE.

OVER THE PAST YEAR, DOE HAS DONE A MAGNIFICENT JOB OF INITIATING THE IMPLEMENTATION OF THEIR MARKET-DRIVEN STRATEGY, PRINCIPALLY THROUGH THE UTILITY SERVICES CONTRACT AND ITS PROVISIONS. OVERALL, THEIR POLICIES AND PLANS ARE INCREASINGLY MORE MARKET ORIENTED, A QUALITY THAT WE FIND VERY GRATIFYING.

CENTRIFUGE TECHNOLOGY IS OBVIOUSLY AT A SIGNFICANT CROSSROAD THIS YEAR AND ITS ENORMOUS ECONOMIC BENEFIT TO THE U.S. CAN BE SWIFTLY REALISED OR INDISCRIMINATELY DISCARDED. AS THE DOE ENTERPRISE MANAGERS AND REVIEWERS MAKE THEIR PIVOTAL TECHNOLOGY SELECTION AND DEPLOYMENT DECISIONS, WE BELIEVE IT IS

CRITICAL THAT CONGRESS HELP SUPPORT A PRUDENT BUSINESS-ORIENTED ATMOSPHERE FOR THE DECISION AND POTENTIALLY ASSIST BY ALLOWING DEBT FINANCING OR SOME TYPE OF REVOLVING FUND. EXCESSIVELY NEARSIGHTED FISCAL ZEAL MUST BE AVOIDED IN FAVOR OF WISE, LONG-TERM ECONOMIC PLANNING, STABILITY AND IMPLEMENTATION.

WE ASK THAT YOU LOOK CRITICALLY AT THE CONCEPT OF PLACING UNDUE RELIANCE ON THE QUESTIONABLE COMBINATION OF THE AGING, ENERGY-INTENSIVE GASEOUS DIFFUSION PLANTS AND THE UNPROVEN, HIGH-RISK YEAR-2000 AVLIS PROCESS AND ITS REQUIRED NEW AND DIFFERENT INDUSTRIAL INFRASTRUCTURE. WE ASK THAT YOU TEMPER THE DEMANDS OF THOSE WHO WOULD SEEK LARGE NEAR-TERM TREASURY REPAYMENTS FOR 40-YEAR OLD PLANTS WHOSE MAJOR INITIAL CONSTRUCTION JUSTIFICATION WAS NATIONAL DEFENSE. WE ASK THAT, IN GENERAL, YOU TAKE ACTIONS TO STABILIZE THE URANIUM ENRICHMENT INDUSTRY.

FOR EXAMPLE, YOU SHOULD IN OUR OPINION URGE DOE TO TAKE ALL NECESSARY STEPS TO EFFECTIVELY COMPETE FOR THE LARGE UNCOMMITTED CUSTOMER DEMAND THROUGH INNOVATIVE MEANS, SUCH AS INCENTIVE PRICING. INCREASED SALES WOULD PROVIDE HIGHER REVENUES WHICH COULD BE PUT TO GOOD USE FOR ADVANCED TECHNOLOGY DEVELOPMENT AND PREDEPLOYMENT, AS WELL AS FOR MODERNIZATION OF ENRICHMENT PRODUCTION FACILITIES. THIS WOULD BE THE BEST POSSIBLE SIGNAL TO OUR DOMESTIC AND INTERNATIONAL UTILITY CUSTOMERS OF U.S. RESOLVE AND U.S. RELIABILITY AS A FUEL SUPPLIER.

WE SINCERELY APPRECIATE THE OPPORTUNITY WHICH YOU HAVE PROVIDED US TODAY, MADAM CHAIRMAN, TO EXPRESS OUR VIEWS ON THE CENTRIFUGE PROGRAM AND ON THE U.S. ENRICHMENT ENTERPRISE AS A WHOLE.

Mrs. LLOYD. Thank you very much, Mr. Rowan. I regret that we did have to curtail some of our time, but I hope that all of you will be assured that your complete testimony will be made a part of the record. Your testimony in its entirety will be in the record.

Mr. ROWAN. Thank you very much.

Mrs. LLOYD. Also, since we have run over because we had to have two or three recesses today, there are some questions I am not going to get time to ask all of you today, so I hope all of you will agree to questions in writing, if you will as soon as possible return them to me so they can be made a part of the record of this hearing today because this is, I believe, one of the most important hearings that we have, so I will ask all of you to comply with that request and I thank you very much.

Mr. Sommerfeld, what would be the impact—this is a question I asked the other witnesses today—on staff levels in the AGC Program if no additional funds are reprogrammed by April 1? I hope you will indicate whether the affected staff are Martin Marietta or other contractors and also, second, what tasks they are carrying out. If you would, identify the staffs, the AGC activities that are carried out by these members of your group between April 1 and May 15 if additional funds are not reprogrammed, and then what minimum level of reprogrammed funding—and this is very important—is required to sustain the minimum of AGC development by retention of all staff from May 15 through the remainder of 1985, fiscal 1985, consistent with the choice of AGC as the selected technology.

Mr. SOMMERFELD. OK. Before the period of April 1 through May 15, for the AGC Program alone—I am not speaking of anything other than the AGC Program—we do not anticipate actual layoffs of individuals. We do anticipate some placement of individuals where other job opportunities, other needs are occurring, and the program has peaked in terms of its testing phase. We would require an additional $5 million between the period of April 1 and May 15, whose primary purchase would be the purchase of test vehicles, advanced gas centrifuges, manufactured by the CM's, to be fabricated, assembled, and go into the testing mode to expand the body of information and data that we have currently accumulated in the program.

From the period of time of May 15 through September 30 I would estimate that we would need an additional $10 million, about $10 to $11 million, or the total amount of money approximately $15 to $16 million. Now, should the reprogramming not occur in terms of additional funding after May 15, there will very certainly be significant manpower impacts.

Mrs. LLOYD. What are the manpower groups that will be affected?

Mr. SOMMERFELD. Well, I think that there will be effects throughout all of the manufacturers. Certainly at Boeing, at Garrett, at Goodyear, and at Martin Marietta there will be impacts in the entire research and development and testing program.

Mrs. LLOYD. But how many will be laid off after May 15?

Mr. SOMMERFELD. Well, I think the answer to the layoff question depends upon, one, the decision that is made in May and the program that is defined for fiscal year 1986, what kind of a base program, how rapid it is. I think it's safe to say that several hundred people are going to be affected as a result of the decision in May of 1985.

Mrs. LLOYD. Well, which way? If AGC is selected, is it——

Mr. SOMMERFELD. The AGC Program will shrink in number of people regardless of the decision. That is to say that if the AGC Program is selected, it will still be trimming down because a number of activities are complete. If the AGC Program is not selected, then the ramp-down of personnel would be even larger.

Mrs. LLOYD. Well, what is your understanding of the agreement between then-Secretary Hodel and the Science and Technology Committee leadership with respect to funding of the losing technology from May 15 through fiscal year 1986? Has the DOE indicated what minimum funding was agreed on for 1986 to support the losing technology?

Mr. SOMMERFELD. Well, I'm afraid I am not aware of any agreement personally that might have been reached, but the Department of Energy has indicated for fiscal year 1986 that the backup technology would be funded at something approximating $25 million to $30 million, and I think you heard George Jasny earlier say that he viewed the range as more like $25 to $50 million and probably at the upper end of it. We have talked about it. We have not concentrated on a plan to lose but we have generally talked about numbers that look like $25 to $40 million in that timeframe, for fiscal year 1986.

Mrs. LLOYD. Thank you. I have some questions, general questions that I would like to ask for the manufacturers.

In your collective judgment, would it make economic sense to deploy the advanced machines in only two buildings of GCEP? Mr. Rowan?

Mr. ROWAN. Yes, I do. I think that that's a proper first step toward full deployment of the machine.

Mrs. LLOYD. What do you mean by that? Would you expand?

Mr. ROWAN. Well, yes. The two buildings, of course, are in place. There is a sunk Government investment that has been made in those buildings. It's a relatively minor engineering change to the building, to those two buildings, to make them suitable for the operation of set V machines, and of course the centrifuge manufacturer industrial infrastructure is in place that would allow them to be readily supplied.

Mrs. LLOYD. How many buildings do you think they should build at Portsmouth?

Mr. ROWAN. Oh, well, I think that the diffusion plant should be shut down and the entire capacity replaced eventually with centrifuge technology. That would lead to the completion of the current four-building plan, and then I think it's really optional on DOE's part where the remaining capacity might be installed. That could be at Oak Ridge or any site selected by DOE.

Mrs. LLOYD. Mr. Grant, Dr. Emmett testified that AVLIS cost could be as low as $15 or $25 per SWU. How does set V centrifuge cost compare with this?

Mr. GRANT. Well, let me delineate that by saying that we talk in terms of $40 to $45 for the centrifuge, and I guess that I can perhaps even go a step further after the years of experience with these machines at present. I can say to you today that the set V centrifuge as currently configured and envisioned will not produce centrifuge SWU's that can be sold for $15, probably not even for $25, so that if in fact this committee, the PEB, or whoever it is that is involved in the decision process is convinced that the new technology will provide separative work at $15 or $25 at some date certain that you can plan on, then you should in fact select that technology immediately and press on forthwith.

Mrs. LLOYD. I think I should emphasize that this committee will not be making this decision, that this is a decision that DOE will be making.

Further, Mr. Grant, you discussed the learning curve in your testimony as an illustration of important cost implications. If all of you should have to stop your production operations, how large do you think the cost impact will be on the set V deployments?

Mr. GRANT. Well, the curve that I showed you, for example, was one that you might have noticed had some bumps on it rather than being a straight line as the classical learning curve might suggest. Each one of those bumps represented a disruption of some kind and some magnitude in the program, and of course represents costs that are accumulated in it. With a delay of 2 years in the production program, it's my estimate that the entire learning curve will have to be reexperienced on set V, and that equates to in set III's case approximately $100 million, and I think that that's about the same bump that you can expect to receive on set V for disrupting the learning curve.

Mrs. LLOYD. Mr. Whitchurch?

Mr. WHITCHURCH. Madam Chairman, we have actually estimated the difference in the 2 years, and it's $80 million in our costs.

Mrs. LLOYD. Would you repeat that?

Mr. WHITCHURCH. It's $80 million increase in our costs for the same number of machines because of the delay.

Mrs. LLOYD. $80 million? All right. Mr. Rowan?

Mr. ROWAN. Our estimates are very similar to those that Mr. Grant and Mr. Whitchurch have indicated to you. They are in that range of $75 million to $100 million.

Mrs. LLOYD. Thank you very much. I have a couple more questions for you but I would like to make this next vote and I'll come back. Is that agreeable with you gentlemen? If any of you have to leave, I will excuse you, but if you're here when I get back I've got a couple more questions to ask you. Thank you.

[Recess taken.]

Mrs. LLOYD. The subcommittee will resume session.

Mr. Grant, you submitted a proposal to the Department of Energy for revising the way it does business on centrifuge development with the private sector. Would you describe the basics of your proposal to the committee, and Mr. Rowan, I would like for you to comment on it after he finishes. OK? Thank you.

Mr. GRANT. I think you have seen some evidence of the general thrust of the proposal. The proposal that we made presumed that the revenue situation that the Government was living with and that all the other facets of the marketplace as they had described it to us were in fact accurately portrayed, and I have no reason to believe they weren't. What we thought the situation was under those circumstances was that the program had had to, in order to stay within those revenues, now, to go below the threshold of a rational program as current described—a good program but not doable under those terms. What that means is that they are at a point where they can no longer simply reduce everybody some and do a little less and take a little longer and still have a viable program.

So what we recommended was that the DOE reduce immediately from three centrifuge manufacturers to one; give that one a business base that would keep both his company and his work force motivated; and provide the kind of long-term staying power that you would need to ride out an early time period; but not to structure a program that just manages to squeak by within the revenues. Rather, if this were a private sector business—by the way, that's the approach we took to it, is if we owned this business, not necessarily as a private sector, but if we owned this business this is what we would do—we would try to produce the maximum positive cash flow in these early years without taking advantage, necessarily, of just squeaking by under the budget level. All the contractors would come down. Fixed costs would therefore be—I say "come down," fewer in number—fixed costs would therefore be reduced.

Let me remind you of a feature of these kinds of programs: When they were put together and structured at the time, especially when you built capacity of various kinds to support a program that is initially structured in some larger quantity, the fixed costs that a contractor incurs tend to be 15 to 20 percent of the total cost to the Government. If that program then is cut in half, then the fixed costs are 30 to 40 percent of the total cost. The next step beyond that, of course, if it is cut in half again there is hardly anything left over for doing productive work and it's all being consumed by fixed costs.

Now in the case of the private sector those fixed costs have to somehow or other be taken care of because our stockholders require it. That's why I said that perhaps, if there was not a business base, the Government would be better served by contractors without an investment because in that case the Government's fixed costs go on in facilities operated by GOCO contractors for other reasons. We can't do that.

Mrs. LLOYD. Thank you. I think you basically referred to this in your testimony, Mr. Rowan. Would you like to comment further?

Mr. ROWAN. Just quickly, Madam Chairman. Our basic philosophical tenets are very similar to those that Dick has very eloquently expressed here on it, but there is some differing approach in implementation in our proposal to DOE. But, stated in its simplest terms, we were trying to cope with the presenting problem statement given to us by DOE, which was revenue shortfall, declining budget availability to do all the work, and a disinclination—understandably—to go beyond a net zero appropriation situation. A further objective was how to rearrange the work in a way that would preserve as much as possible of the commercial/industrial infrastructure that has so painfully been put in place over the last 4 or 5 years.

So, taking all those factors into account, we proposed to them a cost incentive kind of approach to doing the predeployment work with emphasis on a very rapid and aggressive reliability growth program on the centrifuge, and to do that in a way where there was both financial and technical risk of increasing proportion assumed by the contractor. Then that piece of the offering was combined with another piece related to production, and the production piece of it was directed at two major objectives we thought DOE and the Congress would want. Those are the idea of fixed price production to put a cap on the cost of production units, and coupling that with an offer of deferred payment in the front end of the program to help, if it was necessary, to deal with the shortfall in the revenue. So those are the basic features of the plan.

Mrs. LLOYD. Well, thank you very much. Thank you, gentlemen, for being here today. I do apologize for the length of our hearings but I think our testimony has been very good and you have done an excellent job. Thank you.

I would like to ask the remaining witnesses to try to deliver their remarks within 10 minutes, if possible, since we have had the statements in advance and we have previously reviewed them. It is appropriate for the witnesses to summarize their statements so that we can ask more questions, but your entire testimony will be included in the record.

Our next witness is certainly no stranger to this committee. He is Dr. George Cunningham, who is director of the MITRE Institute. We're glad to have you with us today.

Dr. CUNNINGHAM. Thank you very much, Madam Chairman. It's a pleasure to be here again.

Mrs. LLOYD. Please proceed with your testimony.

STATEMENT OF DR. GEORGE W. CUNNINGHAM, DIRECTOR OF THE MITRE INSTITUTE, MITRE CORP.

Dr. CUNNINGHAM. I appreciate the opportunity to appear before you and comment on the Uranium Enrichment Research and Development Program.

As you know, this program was initiated in World War II. It was and remains today a highly classified effort. Safeguarding material and technology is difficult, and our approach to classify was successful for many years, but today we face the problem of increasing world competition because those technologies are now available to other countries. This has resulted in a drastic impact on our former monopoly position.

In the past the marketing was cost-driven. We charged what it cost. It was not value-driven. In the open market, when the value is high, we can claim large profits on the basis of the prices that we set. On the other hand, the price cannot be set to include inefficient production cost at a time when the value is low. Yet, as the program is presently structured it does contain many cost inefficiencies which were built into the original program, and all of those costs must be recovered according to the present cost accounting procedures.

Unfortunately, we then therefore have to consider recovering cost from large engineering staffs, large R&D programs, and long-term commitments to purchase large blocks of electric power because the program was service-oriented. We always insisted that weapons material must be delivered when needed and we always insisted that utilities must have material on the date that they specified.

At the same time, because of the security requirements there was very little outside scrutiny or evaluation of the program, and even the participants were compartmentalized in terms of access to information. In particular, this compartmentalization was detrimental to the R&D program. The gas centrifuge was being developed as a part of the production program and it was not subject to review by the nuclear community or even by other DOE laboratories. On the other hand, the Laser Isotope Separation Programs were separately funded as part of the nuclear energy R&D effort and were not considered a main line enrichment effort, and therefore they did not get the feedback from the production and the operation people.

Today, with both of the programs under the direction of John Longenecker and Jim Vaughan, all of this has changed. The technology programs, as you know, have recently been subjected to an exhaustive review for the Process Evaluation Board, and I believe it is not only proper but urgent to select the technology for future deployment and that a success-oriented research and development program be planned and implemented. Research and development costs leading to possible deployment of both these systems would be very expensive, possibly $600 million to $1 billion, and it's neither reasonable nor necessary to expect the utility customers to bear this cost.

We're fortunate in that we have two good technologies to select from and both are technically feasible operating systems. We need a lot of engineering and reliability data before we can accurately predict the economics of the systems but I am confident that both are economically viable. Thus I believe the risk of making a wrong decision is very low and a properly designed research and development program can mitigate the few risks that remain.

First of all, the R&D program pace and timing should be driven by the needs of the production program. As already indicated by DOE, we can expect substantial cost savings as improvements are made in the manner of operating the gaseous diffusion plants. We have far more capacity than we need for several decades. At least one diffusion plant can be closed. More use can be made of off-peak power, and large engineering and support staffs can be reduced. In short, we can compete on the world market with gaseous diffusion plants for at least 20 years.

A careful review of DOE's demand curves and the projected competitive world market values for SWU's clearly shows two factors: One, on the basis of production costs alone DOE can meet all potential demands into the 1990's with gaseous diffusion alone, and at a competitive price. Two, if GCEP is built right away, the requirement for total recovery of costs will force DOE to price SWU's well above world market prices for several years and probably will result in lower revenues. In fact, if DOE is required to pay back sunk costs on GCEP at this time, there is a real possibility that the R&D program would have to be reduced drastically or curtailed. They simply could not meet the cost of matching the revenues with the outlays.

Now in a competitive market low-cost technologies should be introduced as soon as feasible, but not in a massive capital-intensive process. With relatively small units—and by that I mean $1 to $3 million SWU units—modules could be added according to market needs. With this approach, the DOE can conduct a cost-effective R&D program, solving problems and introducing improvements without having to design around critical items awaiting R&D results.

Both of the technologies under consideration require some very sophisticated, high-technology applications to be successful in the marketplace, and that's one point I would like to make abundantly clear. Both are also important in terms of national security, nonproliferation, and safeguards. In other words, a new technology needs to be introduced somewhat earlier than would be required strictly on the basis of demand.

But the R&D program must have early input of the production enterprise as well. Timing will be somewhat different depending on the technology selected because longer term tests and demonstrations will be required to establish the economic viability and reliability of the centrifuges. On the other hand, changes in technology occur more rapidly in laser technology, and deployment at too early a stage could foreclose future opportunities. Thus, a reasonable R&D program and one which can be supported by revenues would be a program requiring immediate selection of a preferred process followed by a detailed plan for R&D which would be flexible enough to permit deployment to begin as early as the mid-1990's and as late as the year 2000.

The DOE has projected an R&D budget of $150 million for fiscal 1986. That budget is reasonable if an early decision is made to select the preferred technology. Results of the ongoing review are adequate to plan a detailed Development and Demonstration Program leading to construction and operation of a demonstration plant. The major outstanding technical and economic issues have been identified, and many of these issues involve component or subsystem lifetimes, reliability, and efficiency of operation.

While proceeding with demonstration of the preferred system, I would recommend a limited backup effort to address a few critical issues on the technology not selected. Regardless of the technology decision, continuation of GCEP with set III machines cannot be justified. Operation of the installed units to obtain engineering data and operating experience may be justified, but only as a part of the R&D program, not as a part of the production plan.

In summary, Madam Chairman, I believe DOE has been taking a prudent approach to the enrichment program but I urge you to support three actions by DOE: One, make a decision on the reference process in May. Two, develop a detailed R&D program which spreads cost over 8 to 10 years without early commitments for large capital expenditures, but which assures availability of the new technology when needed. And, three, stop construction of new capacity for several years.

Thank you very much.

[The prepared statement of Dr. Cunningham follows:]

DRAFT STATEMENT OF DR. GEORGE W. CUNNINGHAM
BEFORE THE
COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION
28 FEBRUARY 1985

Madam Chairman and members of the Subcommittee. I appreciate the opportunity to appear before you and comment on the Uranium Enrichment Research and Development Program. Since the program was initiated in World War II, it was and remains today a highly classified effort. Safeguarding material and technology is difficult and our approach to classify was successful for many years but technologies are now available to other countries which have drastically impacted our monopoly in the market place. In the past, marketing was cost driven--not value driven. In the open market when value is high, the price can be set to make large profits but when value is low, inefficient production costs cannot be swept into price. Yet as the program is presently structured all costs must be recovered including those inefficiencies. Unfortunately, cost inefficiencies were built into the program including large engineering staffs, large R&D programs, and long-term commitments to purchase large blocks of electric power because the program was service oriented i.e., weapons material must be available when needed and utilities were promised exact delivery times. At the same time, because of security requirements there was very little outside scrutiny or evaluation of the program; even the participants were compartmentalized in terms of access to information.

In particular the compartmentalization was detrimental to the R&D program. The gas centrifuge was being developed as a part of the uranium production program and was not subject to review by the nuclear community or even by other DOE laboratories. On the other hand, the Laser Isotope Separation programs were separately funded as a part of the Nuclear Energy R&D effort and were not considered as a mainline enrichment effort. As a personal example, when I was Assistant Secretary for Nuclear Energy, I was responsible for the AVLIS program, but I had only limited access to information on the Advanced Gas Centrifuge Program. Today with both of those programs under the direction of John Longenecker and Jim Vaughan, all that has changed. The technology programs have been subjected to an exhaustive review for the Process Evaluation Board, and I believe that it is not only proper but urgent that a decision be made to select the technology for future deployment and that a success-oriented research and development program be planned and implemented. Research and Development costs leading to possible deployment of both these systems would be very expensive, possibly $600 million to $1 billion and it is neither reasonable or necessary to expect the utility customers to bear this cost. Also we are fortunate in that we have two good technologies to select from and both are technically feasible operating systems. We need a lot of engineering and reliability data before we can accurately predict the economics of the systems, but I am confident that both are economically viable. Thus, I believe that the risk of making a wrong decision is very low and a properly designed research and development program can mitigate the few risks that remain.

First of all, the R&D program pace and timing should be driven by the needs of the production program. As already indicated by DOE testimony, we can expect substantial cost savings as improvements are made in the manner of operating the gaseous diffusion plants. We have far more capacity than we need for several decades. At least one plant can be closed, more use can be made of off-peak power, and large engineering and support staffs can be reduced. In short, we can compete on the world market with gaseous diffusion plants for at least 20 years. A careful review of DOE's demand curves and the projected competitive world market values for SWU's clearly shows two factors. One, on the basis of production costs alone, DOE can meet all potential demands into the 1990's with gaseous diffusion alone and at a competitive price. Two, if GCEP is built right away the requirement for total recovery of costs will force DOE to price SWU's well above world market prices for several years and probably will result in lower revenues. In fact, if DOE is required to pay back sunk costs on GCEP at this time, there is a real possibility that the R&D program would have to be reduced drastically or curtailed.

Nevertheless, in a competative market, low cost technologies should be introduced as soon as feasible, but not in a massive capital-intensive process. With relatively small units (1 to 3 million SWU's), modules could be added according to market needs. With this approach the DOE can conduct a cost effective R&D program, solving problems and introducing improvements without having to design around critical items awaiting R&D results. Both of the technologies under consideration require some very sophisticated high technology applications to be successful in the market place, yet both are also important in terms of national security, non-proliferation, and safeguards. That is, a new technology needs to be introduced somewhat earlier than would be required strictly on the basis of demand.

Timing will be somewhat different depending upon the technology selected because longer term tests and demonstration will be required to establish the economic viability and reliability of the centrifuges. On the other hand, changes in technology occur more rapidly in the laser technology and introduction at too early a stage could foreclose future opportunities. Thus, a reasonable R&D program and one which can be supported by revenues would be a program requiring immediate selection of a preferred process, followed by a detailed plan for R&D which would be flexible enough to permit deployment to begin as early as the mid-1990's and as late as 2000.

The DOE has projected an R&D budget of $150 million for FY 1986. That budget is reasonable if an early decision is made to select the preferred technology. Results of the on-going review are adequate to plan a detailed development and demonstration program leading to construction and operation of a demonstration plant if the major outstanding technical and economic issues have been identified. Many of these issues involve component or subsystem lifetimes, reliability, and efficiency of operation. While proceeding with demonstration of the preferred system, I would recommend a limited backup effort to address a few critical issues on the technology not selected. Regardless of the technology decision continuation of GCEP with Set III machines cannot be justified. Operation of the installed units to obtain engineering data and operating experience may be justified but only as a part of the R&D program--not as part of the production plan.

In summary Madam Chairman, I believe DOE has been taking a prudent approach to the enrichment program, but I urge you to support three actions by DOE:

(1) Make a decision on the reference process in May.

(2) develop a detailed R&D program which spreads costs over 8 to 10 years without early commitments for large capital expenditures, but which assures availability of the new technology when needed and

(3) stop construction of new capacity for several years.

Mrs. LLOYD. Thank you very much, Woody.

Knowing of your nuclear background, how has MITRE Corp. been involved in the uranium enrichment business?

Dr. CUNNINGHAM. MITRE Corp. is involved in the present program in terms of supporting the DOE, primarily in terms of assuring that backup information is made to both the DOE and the Process Evaluation Board to assure that an objective and fair evaluation can be made of the technologies concerned.

Mrs. LLOYD. Are there any management changes or other changes to the Enrichment Program that could be implemented, in your opinion, to reduce the cost of the enrichment service?

Dr. CUNNINGHAM. I think that there have been some significant changes begun with the gaseous diffusion plants, and I think that has come about largely because DOE has requested the gaseous diffusion people to find a way to make themselves competitive. I think as a result of that was the reason that they were able to work out with TVA the off-peak power requirements. I think——

Mrs. LLOYD. Well, I would like to think a few Members of Congress had something to do with that, too.

Dr. CUNNINGHAM. Yes, certainly from the TVA side. [Laughter.]

No, there is no question about that, but what I'm saying is in terms of the operation of the plants, Mrs. Lloyd. I believe that the gaseous diffusion people were never really asked to compete in the world market. They were asked to run the diffusion plants and to meet the production requirements but they were never told that they now have to deal with an open market. I think now that the DOE has told them this, that they themselves are clever enough to find some more ways of efficiently producing uranium. This is the reason that in my testimony I refer to the fact that I believe that with gaseous diffusion alone, that we can compete in the world market.

Mrs. LLOYD. Well, as you brought out, you consider both technologies to be good technologies. They are fine technologies, so at what level would you recommend that the losing technology be funded so that we can make sure of its availability, if in the unforeseen future we decide this is exactly what we have to have to maintain our share of the world market?

Dr. CUNNINGHAM. The range which has been mentioned, $25 million to $50 million, but I would suggest that probably can be done on the lower end of that because it depends with the two different technologies. In the case of the centrifuge technology there are certain critical areas, particularly relating to reliability and long-term operation, which need to be pursued.

In the case of the laser technology there also are critical areas which need to be evaluated, but you have a somewhat different advantage in the case of the laser technology in that there is other research going on in other programs around the world, too, and in the United States. I think by taking advantage of that you can also, again, reduce the total amount required for the backup programs.

Also, the timing on the deployment is such that if there were a complete failure of the reference system it would not be drastic to have a 1-, or 2-, or even a 3-year delay in terms of the deployment of the backup system.

Mrs. LLOYD. One final question: Since money is the obvious point of concern today, what do you think about a revolving fund or the formation perhaps of a separate corporation that has borrowing authority? Do you think this would be a positive way to reform the financial administration of the uranium enrichment enterprise?

Dr. CUNNINGHAM. Well, I think that might be helpful, Mrs. Lloyd, but I also think that probably the thing that would be most helpful is the item that you referred to earlier when you mentioned the fact that the GAO had considered the writeoff of obsolete or previous investments as being, in their view, illegal. I am not qualified to judge the legality of that but I do say that if the DOE is required to act in a businesslike way, they should have permission to write off bad investments, they should have permission to writeoff obsolete facilities, and that I think would probably be far more helpful than just the revolving fund per se.

Mrs. LLOYD. Well, thank you so much. You've been a great witness and it's good to see you again today. Thank you.

We welcome now Mr. Arthur Lundvall, who is vice president for supply of Baltimore Gas & Electric Co. We are very happy to have you here. Please proceed with your testimony.

STATEMENT OF ARTHUR LUNDVALL, VICE PRESIDENT FOR SUPPLY, BALTIMORE GAS & ELECTRIC CO., REPRESENTING THE EDISON ELECTRIC INSTITUTE, ACCOMPANIED BY LORING E. MILLS, VICE PRESIDENT, EDISON ELECTRIC INSTITUTE

Mr. LUNDVALL. Thank you, Madam Chairman.

I am Arthur Lundall, vice president of Baltimore Gas & Electric Co., and I am also chairman of the Edison Electric Institute Nuclear Power Executive Advisory Committee. With me today is Loring E. Mills, who is vice president of the Edison Electric Institute for Nuclear Activities. We are pleased to have the opportunity to appear before you today to discuss the Department of Energy's uranium enrichment activities management in the fiscal year 1986 budget request.

Baltimore Gas & Electric Co. operates two nuclear powerplants with 1,700 electrical megawatt capacity, which in 1984 provided over 57 percent of our customers' needs. In support of these plants, BG&E purchases enrichment services at a cost of approximately $31 million per year. Last year BG&E converted its requirements enrichment contract to the utility services enrichment contract, and we expect to save $5 million per year in fuel costs for our customers as a result of this action.

This testimony is also provided on behalf of the Edison Electric Institute, the national association of the investor-owned electric companies. EEI membership includes the vast majority of DOE's domestic uranium enrichment services customers. Nuclear energy provided nearly 14 percent of the Nation's electricity during 1984. Eighty nuclear plants were in commercial operation at the start of 1985 with a capacity of 64,932 electrical megawatts. Nuclear powerplants are and will continue to be necessary to provide the electricity to help to drive our economy and maintain it in the future.

The DOE fiscal year 1986 budget request is $12.5 billion. When looking at the civilian nuclear programs alone, the revenues projected from electric utilities in fiscal year 1986 will fund over three quarters of the DOE civilian nuclear budget. Thus, the electricity customer rather than the general taxpayer is providing the funds for most of the DOE civilian nuclear efforts.

Relative to uranium enrichment, a reliable source of competitively priced enrichment is necessary if nuclear-generated electricity is to retain its economic advantage. Foreign suppliers are offering very attractive contracts, and in the interest of our electricity customers we must consider these sources and purchase the services when the conditions warrant.

Historically, from September 1973 until January 18, 1984, enrichment contracts offered by DOE were take-or-pay arrangements that required the customers to make firm commitments for an extended period and to take delivery of the service whether it was needed or not. This frequently resulted in the building of costly inventories of enriched uranium or, conversely, paying prohibitive termination charges.

Then as nuclear units experienced delays or were cancelled, this produced an untenable situation that upset the fundamental balance between supply and demand for enrichment services. Enrichment service purchasers and suppliers, foreign and domestic, were facing a chaotic market situation with partial contract cancellations and utilities become major sellers on the secondary market.

Clearly, something had to be done or DOE would be in real trouble as a primary enrichment supplier. DOE responded on January 18, 1984, by offering the utility services enrichment contract. The U.S. contract was offered after a 2-year effort, which included a public comment period, to develop workable, mutually compatible, competitive, market-oriented contractual arrangements.

The new contract permits DOE to be a competitive supplier. The U.S. contract is a major part of DOE's strategy to manage its enrichment program more effectively, and this contract is a fair compromise between the customers' needs, DOE's constraints, and foreign competitive offerings.

The U.S. contract provides the utilities assurance of supply, added flexiblity in dealing with overstocked inventories, and an opportunity to maintain reasonable costs to ratepayers. Under the contract, DOE can ensure the revenues it needs to maintain services and to permit the continuation of construction and a reasonable level of development of new technology.

It is extremely important that the United States have a strong uranium enrichment program to support the current and future operations of the Nation's nuclear powerplants and to help support the Nation's nuclear nonproliferation goals. In this regard, DOE must rely on the most up-to-date technology to contain the ever-rising cost of uranium enrichment.

But regardless of what DOE is able to do in the near term on cost control and businesslike practices to reduce the SWU price, the high cost of production by the current technology as compared to newer technologies will ultimately prevent DOE from meeting its competition and fulfilling its promise to its customers. We are aware that there is not sufficient capacity in the foreign producers' facilities at this time to fill our domestic needs. Such facilities, however, can be provided by the foreign producers in a reasonable period of time.

The rate of retention by DOE of its domestic customers will be greatly influenced by DOE's dedication to a program of future development designed to contain and lower its production costs. Therefore, there is an undeniable economic rationale for pursuing the development of a preferred advanced enrichment technology.

Both of the advanced uranium enrichment technologies—advanced gas centrifuge and atomic vapor laser isotope separation—appear to have advantages over the gaseous diffusion process from the customer's standpoint. DOE has indicated that it will make a technology choice in May 1985. Our interest in this decision is to be certain that the choice is made in a manner consistent with the best interests of those to be served by the decision—the electricity customers.

We firmly believe that this decision should be made in May. Each of the two processes has over a decade of research and development background, and enough is now known to make the needed choice. DOE's technology decision will simply select which of the two advanced technologies will be pursued through the demonstration phase. It is not a decision to deploy on a commercial basis a specific new enrichment facility. The decision to deploy will be made later and will be based on a better understanding of enrichment economics and capacity needs. We endorse this approach.

Electricity customer funds are not sufficient to continue the development of two advanced technologies at the pace and funding level they are being pursued during the current selection process. A decision one way or the other is needed now. While external financing is one means of providing the funds for future construction and development, there are other sources of cash within the DOE enrichment program that should be fully explored.

DOE appears to be vigorously exploring cost reduction alternatives, including the charges for energy not taken, the retirement of facilities not necessary to meet its contract obligations, and operational cost savings. We urge DOE to continue to explore ways to economize within the enrichment enterprise, as any efficient business must.

Incidentally, we are pleased to hear today of the success that DOE has had, along with its contractor, reducing the cost of electric power through the use of interruptible services with TVA. It is clear that DOE is responding to the needs of its customers, taking bold steps to improve its market position, to lower future costs, and to remain a reliable, competitive suppliers of enrichment services.

DOE, through the new U.S. contract, has made a commitment that recognizes the industry's needs. We fully support the need for the United States to continue to be a major supplier of enrichment services for the world and to do so on a basis that provides an assured long-term supply capability at a cost that is competitive with other suppliers.

I thank you for this opportunity to present our views on DOE's program, and I would be happy to answer your questions.

[The prepared statement of Mr. Lundvall follows:]

EDISON ELECTRIC INSTITUTE
TESTIMONY BEFORE THE
SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
ON THE
DEPARTMENT OF ENERGY URANIUM ENRICHMENT ACTIVITIES MANAGEMENT AND FY 1986 BUDGET REQUEST

FEBRUARY 28, 1985

Chairman Lloyd and Subcommittee members, I am Arthur Lundvall, Vice President of Baltimore Gas and Electric Company and Chairman of the Edison Electric Institute Nuclear Power Executive Advisory Committee, the most senior EEI committee devoted exclusively to matters involving nuclear energy. With me today is Loring E. Mills, EEI Vice President for Nuclear Activities. We are pleased to have the opportunity to appear before you today to discuss the Department of Energy's Uranium Enrichment Activities Management and FY 1986 Budget Request. It has been precisely one year since the utility industry last appeared before you to discuss this important subject.

Baltimore Gas and Electric Company (BG&E) operates two nuclear power plants with 1700 MWe capacity, which in 1984 provided over 57 percent of our customers' needs. In support of these plants, BG&E purchases enrichment services, at a cost of approximately $31 million per year. Last year BG&E converted its

Requirements enrichment contract to the Utility Services Enrichment Contract. We expect to save $5 million/year in fuel costs for our customers as a result.

This testimony is also provided on behalf of the Edison Electric Institute, the national association of investor-owned electric companies. Its members serve approximately 96 percent of all customers of the investor-owned segment of the electric utility industry and 73 percent of all ultimate customers in the nation. EEI's members currently operate 71 nuclear power plants with full power operating licenses and 4 with low power licenses. EEI member companies will operate 27 additional plants now under construction. Therefore, EEI membership includes the vast majority of DOE's domestic uranium enrichment services customers.

Nuclear energy provided nearly 14 percent of the nation's electricity during 1984; 80 nuclear units were in commercial operation at the start of 1985 with a capacity of 64,932 MWe. Nuclear power plants are and will continue to be necessary to provide the electricity to help drive our economy and maintain it in the future. Additionally, nuclear power plants have saved billions of dollars for the nation's electricity consumers through savings in fuel costs by, primarily, displacing foreign oil.

EEI Perspective on DOE Civilian Nuclear Budget Request

The DOE FY 1986 Budget Request is $12.5 billion. The civilian portion of this budget is $4.5 billion with the nuclear utilities funding nearly one half of this budget. When looking at the civilian nuclear programs alone, the revenues projected from electric utilities in FY 1986 will fund over three quarters of the DOE civilian nuclear budget. Thus, the electricity customer, rather than the general taxpayer, is providing the funds for most of the DOE civilian nuclear efforts. Therefore, we are compelled to protect the electricity customers interests by seeing that these funds are used effectively and efficiently. Additionally, we note that the budget calls for total revenues from the electric utility industry for uranium enrichment and nuclear waste management services of $2 billion, $571 million more than the services being provided in FY 1986. It appears that our industry and its customers are being used to help fund the deficit.

Uranium Enrichment

Returning to the specific matter at hand. What makes nuclear energy economically desirable is its very low fuel cost as compared with other generation technologies. An indispensable part of the nuclear fuel cycle for our current reactors is uranium enrichment. A reliable source of competitively priced enrichment is necessary for nuclear energy to retain its economic advantage. Foreign suppliers are at our door offering very attractive contracts. In the interest of our electricity customers, we must buy these services at the lowest practical cost from a reliable supplier.

Historical Perspective

Uranium, in its natural state, contains about 0.711 percent of the fissionable isotope U-235 and must be enriched to the range of 2 to 4 percent U-235 for use in a typical light water reactor. This enriching service is what we are buying from DOE in the form of separative work units (SWU).

The original contracts offered by the U.S. government for enrichment services, through 1972, were market-oriented and permitted customers to purchase the service as and when needed at reasonable prices. From September 1973 until January 18, 1984, the only contracts offered were take-or-pay arrangements that required the customers to make firm commitments for an extended period and to take delivery of the service whether it was needed or not. This resulted in the building of costly inventories of enriched uranium or paying prohibitive termination charges.

These Long Term, Fixed Commitment Contracts and Adjustable, Fixed Commitment Contracts produced an untenable situation that upset the fundamental balance between supply and demand for enrichment services as nuclear units experienced delays or were cancelled. Enrichment service purchasers and suppliers, foreign and domestic, were faced with a chaotic market situation with partial contract cancellations and utilities becoming major sellers on the secondary market.

Clearly, something had to change or DOE was going to be driven to its knees as a primary enrichment supplier. DOE responded to the situation by, on January 18, 1984, offering the Utility Services (US) Enrichment Contract. The US contract was offered after a two year effort, which included a public comment period, to develop workable, mutually compatible, competitive, market-oriented contractual arrangements. As DOE has indicated to you, the US contract conversion effort has captured about 90 percent of its previously contracted business. The new contract permits DOE to be a competitive supplier. But to remain competitive, DOE must proceed cautiously and wisely, in a sound business manner, in the selection and deployment of a more efficient enrichment technology.

To meet this goal, while satisfying Office of Management and Budget requirements, expenditures must be fully covered by SWU sales revenues in each Fiscal Year. DOE's yearly pricing calculation, however, cannot explicitly include future construction and development costs. Therefore, the cash required to pay for future technology construction and development is generated by including in the price such accounting items as depreciation and imputed interest.

Current Situation

DOE appears to have struck a delicate working balance among the conflicting objectives that it faces. On the one hand, it must meet its statutory mandate to recover all costs over a reasonable period of time coupled with the Administration's stricture to avoid a net appropriation request in any one year. This objective would tend to move DOE towards higher prices and a need to guarantee its sales through reduced customer flexibility. This, obviously, would drive away customers. On the other hand, in order to hold or expand its market share, DOE must bring its prices in line with its competition and offer relief to its customers who hold large SWU inventories. This objective would tend to move DOE towards lower prices and greater flexibility, which, in turn, may reduce revenue and lead to cuts in the DOE advanced technology programs. Such programs are necessary to develop the capability to bring down enrichment costs over the long-run.

The US contract is a major part of DOE's strategy to manage its enrichment program more effectively. The US Contract is a fair compromise between the customers' needs, DOE's constraints and foreign competitive offerings.

DOE's success in getting its customers to accept the new contracts provides vivid evidence in this regard. We are pleased at DOE's success. The US Contract provides the utilities assurance of supply, added flexibility in dealing with over-stocked inventories, and an opportunity to keep costs to ratepayers reasonable. Under the Contract, DOE can insure the revenues it needs to maintain services and to permit the continuation of construction and development of new technology at reasonable levels. We applaud DOE for its efforts and believe that it has properly addressed the issue.

Additionally, we note that DOE appears to be reorienting its marketing approach such that it can be more responsive to its customers needs. This is very positive. DOE must strive to behave as much like a business as a Federal Agency can.

Along these same lines, we understand that DOE is developing an incentive pricing plan that would not reduce revenues, but would capture a greater market share and perhaps, eventually, increase revenues. EEI endorses such an approach as part of overall attempts to manage the program more effectively.

The Future of the DOE Uranium Enrichment Program

It is extremely important that the United States ha strong uranium enrichment program to support the current future operation of the nation's nuclear power plants and to he support the nation's nuclear non-proliferation goals. To say that the DOE uranium enrichment program should not progress to more economic and efficient technologies, because the current facilities possess sufficient capacity, would be short-sighted, indeed. DOE must bring on future technology to contain the ever rising cost of uranium enrichment. Regardless of what DOE is able to do in the near term on cost control and business-like practices to reduce the SWU price, the high cost of production by the current technology (as compared to the newer technologies) will ultimately prevent DOE from meeting its competition and fulfilling its promise to its customers. If it does not, greater numbers of current customers will find refuge in the secondary market and, eventually, with foreign producers, who can, due to their pricing procedures, national energy policies and foreign exchange rates, underprice DOE in today's market. The loss of market will force up DOE's prices causing more market loss. While there is not sufficient capacity in the foreign producers' facilities at this time to fill our domestic demand, such facilities can be provided in a reasonable period of time.

Under the new US contract, adverse market impacts on DOE are lessened considerably in the near term due to the manner in which the contract guarantees DOE a portion of the market. However, the rate of retention by DOE of its customers in the future will be greatly influenced by DOE's dedication to a program of future development that will contain and lower its production costs. Therefore, there is an undeniable economic rational for pursuing development of a preferred advanced enrichment technology.

Last year, the DOE FY 1985 Budget Request indicated that the size and scope of DOE's new enrichment technology program will be driven by the market response to the new contract and attendant revenues. We endorsed this approach and are most pleased to see that DOE is following through on its promise. DOE indicates that it is proceeding on a schedule to select a preferred technology in May of this year. A number of business decisions will be made based on this selection.

Selection of Future Technology

Both of the advanced uranium enrichment technologies, Advanced Gas Centrifuge (AGC) and Atomic Vapor Laser Isotope Separation (AVLIS), appear to have advantages over the gaseous diffusion process from the customer's standpoint. We are following this work as closely as we can, given the classified nature of the work. Several utility industry representatives hold access clearances that have permitted us to follow the development of the technologies and the selection process. DOE has indicated that it will make a technology choice in May 1985. Our interest in this decision is to be certain that the choice is made in a manner consistent with the best interests of those to be served by the decision -- our electricity customers. We firmly believe that the decision should be made in May and not delayed for any reason. Each process has over a decade of research and development background and enough is now known to make the choice. We plan to be in a position to offer our comments on the decision at the appropriate time.

Deployment of Future Technology

DOE's technology decision will only select which of the two advanced technologies will be pursued through the demonstration phase. It is not a decision to deploy, on a commercial basis, a specific new enrichment facility. The decision to deploy will be made later and will be based on a better understanding of enrichment economics and capacity needs. We endorse this approach.

When DOE proposes its future operating plan details and its program for developing more efficient capability, we will request the opportunity to evaluate the plans and comment on them. In the meantime, we support the continuation of the Gas Centrifuge Enrichment Plant (GCEP) at a reduced level during FY 1986 only if the AGC technology is selected this May.

Funds for Future Development

We are vitally interested in having the most efficient and dependable enriching technology available to serve our member companies. Using DOE's ten-year cost recovery pricing methodology, the Government will recover its costs, as required, for any future construction and development program. It appears, however, that DOE may not have the year-to-year cash flow necessary to perform the research and development that each contractor desires and still avoid net appropriations in each Fiscal Year. DOE has identified in its Budget Request the need to find alternative sources of financing to continue the work necessary to insure the timely availability of the lower cost future technology. We are aware of the problem and are waiting to see what alternatives may be proposed. Some innovative opportunities for financing the development of the new technologies may be necessary if net appropriations are not forthcoming in any year that they may be requested in the future. However, one thing is clear: Electricity customer funds are not sufficient to continue the development of two advanced technologies at the pace and funding level they are being pursued during the current selection process. That is one reason why a decision is needed now.

While external financing is one means of providing the funds for future construction and development, there are other sources of cash within the DOE enrichment program that should be fully explored. DOE appears to be vigorously exploring cost reduction alternatives, including the charges for energy not taken, the retirement of facilities not necessary to meet its contract obligations, and operational cost savings. We urge DOE to continue to explore ways to economize within the enrichment enterprise as any efficient business must to serve its customers properly.

On a related funding matter, DOE indicated that it will start paying back the Treasury for the Government's investment in uranium enrichment. At this point we are uncertain what this entails. However; we will be watching closely to see that the electricity customer is not charged more than once for any investment the Government has made. We are most interested in the basis that will be used for determining the applicable pay back, especially considering that the facilities were originally constructed for military purposes and much of the funds for modifications were provided from customer fees paid for enrichment services.

Conclusion

It is clear that DOE is responding to its customers and taking some bold steps to improve its market position, to lower future costs, and to remain a reliable, competitive supplier of enrichment services. DOE, through the new US contract has made a commitment that recognizes the industry's needs. We support DOE in this regard. Also, we fully support the need for the United States to continue to be a major supplier of enrichment services for the world and to do so on a basis that provides an assured, long-term supply capability at the lowest practical cost that is competitive with the other suppliers. This is not only in the best interest of the nuclear utilities and their customers, but, because of the positive effects on our foreign trade balance and in meeting non-proliferation goals, of the nation.

The recently released EEI Report on Nuclear Power, dated February 1985, indicates that a number of changes must be made if nuclear energy is to be available as an option in the future. Frankly, Madam Chairman, if changes are not made, both in industry and Government, we will not have a growing nuclear energy program. Many of the things we are doing today, including the development of future enrichment technology, will be wasted. The deployment of new enrichment technology only makes sense if nuclear energy is a growing source of electricity production. We believe the nation will need and use the nuclear energy option in the future. We know you do, too. Let's all work together to make the needed changes in our regulatory, design, construction and operating approach to nuclear energy. Everyone will benefit.

Thank you for the opportunity to present the view of DOE's uranium enrichment customers. We will be pleased to answer your questions.

Mrs. LLOYD. Thank you very much, Mr. Lundvall.

Is EEI involved at all in the process development of the advanced technologies?

Mr. LUNDVALL. Not directly, no.

Mrs. LLOYD. Is it appropriate that they could be involved in the technology activity?

Mr. LUNDVALL. I think perhaps I would like to ask Loring Mills to respond to that question. I have some thoughts but I think he's more capable of——

Mrs. LLOYD. That would be fine.

Good to have you with us today.

Mr. MILLS. Thank you. I would like to try to respond to that.

Our involvement is through the payment of funds to DOE, and they in turn are allocating the funds to the contractors who are working on it. Certainly the funds in the program are coming from the utilities. As Mr. Lundvall indicated, most of them are EEI members, so we are directly involved in funding the program.

There are several members of the utility industry who are looking over shoulders, at this point, observing the technology development, trying to understand the advantages of one over the other so that we will be able to comment when the decision is made in terms of what its advantages may be to customers.

Mrs. LLOYD. So you are looking in that direction, to be able to make comment in an advisory capacity?

Mr. MILLS. Yes, we are, but we have no official role in that regard.

Mrs. LLOYD. Do you all agree with DOE's initiative to cut the cost for the enrichment services to their customers so that they can be more competitive with other suppliers?

Mr. LUNDVALL. Well, there's not much question about that. Yes, we do, certainly, and we have had direct experience at Baltimore on our own. Our costs have been cut considerably through this new contract.

Mrs. LLOYD. Well, how would you have DOE modify their policy in order to respond to some of the critics in the uranium mining industry on the price of uranium?

Mr. LUNDVALL. Well, it would seem to me that the matter of producing uranium as is done by the miners and the enrichment processes are two separate processes, and assuming the same tails assay, why the same amount of uranium is going to be needed for a given enrichment process regardless. I think they are two separate entities and they each have their own separate and distinct problems.

Mrs. LLOYD. Well, thank you very much.

Mr. MILLS. May I commend on that, Madam Chairman?

Mrs. LLOYD. Yes. Please respond.

Mr. MILLS. We are very concerned about the domestic uranium supply industry. It really has a problem on its hands at this point, and it has come about through the arrangement of the past several years, of which the enrichment contracts contributed to building up a major inventory of enriched product and also a major inventory of uranium supply. However, when one looks at the total supply and demand question, with this type of a product supply will match demand over some long period of time. We did overproduce throughout the last decade, and we are in the particular situation of working off very large inventories, and it's difficult to come with a direction that will satisfy the needs of being able to produce a significant quantity of material that is well above the actual consumption of the material. We do not have easy answers of how to satisfy the needs of the domestic uranium industry but we are concerned about it.

Mrs. LLOYD. Thank you very much. I think the consensus is today that we do have complexities and we also do not have easy answers, but we're working toward that goal. Thank you both very much.

Our last witness is Mr. Bill Stevens, who is chairman of the Uranium Policy Council of the American Mining Congress. We appreciate your patience, and for being with us today, and we look forward to your testimony as well. Please proceed as you wish. We do have your complete testimony, I believe, so you can proceed.

Mr. STEVENS. Yes, ma'am.

Mrs. LLOYD. Thank you.

STATEMENT OF BILL STEVENS, PRESIDENT, QUIVIRA MINING CO., KERR-McGEE CORP., ON BEHALF OF THE AMERICAN MINING COUNCIL

Mr. STEVENS. Thank you, Madam Chairman, members of the subcommittee.

Let me say first off that, as chairman of the Uranium Policy Council of this American Mining Congress, my primary interest in being here with your committee today is to try and throw a little light on this business of what is going on in the front end of this uranium fuel cycle. My company, by the way, is Kerr-McGee Corp., which has been involved in the production of uranium since 1952.

I want to make a point to illustrate again more or less the status of our industry. Since January 1 of this year, my company has completely closed all its uranium operations, which is more or less indicative of the industry itself, so personally I truly appreciate an opportunity to come here because this may be my last trip into town.

Mrs. LLOYD. Well, we hope you'll come back to see us. We're happy to have you today.

Mr. STEVENS. Well, I truly hope that I do get back some more because I think the problems, as expressed by numerous people here today, of the nuclear fuel cycle, are very complex certainly and it's going to require a tremendous amount of discussion and so forth in the years ahead to bring forth the tremendous capability that this nuclear industry has to offer.

Let me just make some very short comments. Again, you may wonder why I'm here and why this industry is here in this session that really has to do with enrichment and enrichment problems. We're country cousins, I suppose, of the enrichment business, and nobody really pays much attention to us but we're still there, what's left of us. One of the problems that we have really, I think, is because the nuclear enrichment programs have really not had any particular concern about this part of the fuel cycle.

The main theme as expressed by most of these previous witnesses has been that having to do with how can we upgrade enrichment, the exploration and research and so forth, and how can we maintain a long term, dependable, economical enrichment business, the nuclear fuel cycle business. We agree with all of this; we really do. We think the enrichment aspect of this country is a tremendously essential part of whether we succeed in this overall venture or not.

I want to impress upon you, however, that we feel too that the ability of this country to produce the basic uranium to supply for the enrichment process is an absolute essential also, and we are on the verge, we feel, of losing this. We are losing this because of a number of reasons, and a number of these have been expressed before: The oversupply, the abundant oversupply; the lack of any market today to sustain an independent business; and I think it's important to recognize that in this total fuel cycle the uranium industry, the uranium production industry, is really the only essence of free enterprise as an entity in this whole cycle. Everybody else has other things kind of working for them on the side, as you well know.

Mrs. LLOYD. That's a very good point. Thank you.

Mr. STEVENS. I think, Madam Chairman, that it's necessary for people who are truly interested in this business to understand that the nuclear fuel cycle is a tremendously complex thing, as we have said, and it's an integrated thing from beginning to end. One piece can't do without the other. We can't devote all our time and energy to making a successful enrichment enterprise without paying attention to what goes on with these other units. Making all of these things fit together and fit together properly, to the advantage of the total entity, is something that we really haven't achieved yet.

We're very concerned that most of what has come about in our industry, certainly since the late 1960's in the development of private enterprise into this business, has been based on the desires and wants and needs of this enrichment program, at least the front end of the cycle has, and that is not necessarily all bad. This country's enrichment service has provided the market for our product over these 20-some years but it also, because of its policies and practices and so forth, has influenced the negative aspects of our industry, too, that have developed certainly in the last 5, 6, 7 years.

These policies of course are those that led to tremendous oversupply, overenrichment, overrequirement of feed that really was not needed, but to fit the policies of the enrichment industry the feed continued to flow. As a consequence we have this tremendous, overly abundant inventory and resultant zero market.

We are at a crossroads, my industry feels at this time, in this total ability of our country to provide the fantastic aspects that are promised from the nuclear fuel cycle. This crossroad is here because again, and I repeat, the domestic uranium inventory is almost a thing of the past. We have lost about 90 percent of our people—and, by the way, I was interested in the comments being made in some of the research laboratories about the number of people that they are on the verge of losing because of cutbacks in the program and so forth.

One thing the domestic uranium industry has become expert at is these kind of problems, how to get rid of people. We are down from about 22,000 people in our industry now to, the best we can estimate, around 2,000. The first 2 months of this year, three uranium producers have written off almost a quarter of a billion dollars in investment in the uranium industry, so far in January and February.

One of the interesting things in all of this is that the enrichment facilities and the enrichment capabilities of DOE have an obligation that was recognized years ago by the Congress, to participate and assist in maintaining a domestic uranium industry in this country that would be viable and would be there to provide whatever was needed to be provided. The DOE hasn't done this.

We feel that in the things that they have done to encourage improvement in their enrichment enterprise, they have done some great and lordly things and we are very proud of them in that regard, but at the same time they do these things without playing the slightest attention to the effect of these things on us country cousins, and there are very serious effects, some of which I have noted earlier. The DOE has failed in its responsibility. There are laws about this sort of thing, as you well know.

But I think the major emphasis that we want to try and impress your committee with, Madam Chairman, is that if we are going to have in this country—and I think we need to decide if we want this—but if this country is going to have a long-term, dependable nuclear program there has got to be some new decisions made about what happens to the front end of this cycle. If we don't do it soon, I truly think it's going to be too late. The vast majority of new uranium feed in this country is coming from foreign imports, and this is going to continue.

For this country to depend on foreign suppliers, particularly with the enrichment being as important as it is and the amount of money that is invested in it, to put all of this aside and say, "All right, the future of all of this tremendous capability we are going to leave in the hands of foreign governments," we see every day the results of these kind of policies. We have to maintain the domestic uranium industry, and there are some things that we feel, again noting that the overall nuclear capability in this country is tremendously complex, there are some simple things that we think the DOE could do that would help. They would be temporary helps to our industry.

These things, Madam Chairman, include such things that are involved in the enrichment programs, of adopting a variable tails option that would give flexibility to their customers, their utility customers, in determining how much uranium they want to provide to arrive at certain enrichment products. We would encourage and we feel it would be some assistance to us to initiate marginal pricing for enrichment services, particularly above the 70-percent requirements that have been discussed in the U.S. contracts, and that this would be tied to domestic feed.

We feel another aspect that would have some benefit to us these days is whatever additional uranium requirements that the DOE needs to handle this split tails business. Buy it from the domestic producers. We have got all kinds of material to sell and no place to sell it. Why take it out of this country's reservoirs that are there for other purposes, hopefully.

I think another thing that would help would be an encouragement of other Government entities in this country who use uranium feed material to institute a Buy American Program. We need that badly. Again, almost all of the various elements of this fuel cycle, with the exception of the uranium producers, have their influence, either guided by Government entities or some other aspect that can provide relief to them when needed.

I think that one last point, Madam Chairman, that is critically important, I think, in the DOE structure, organizational structure, there is tremendous need for a high-level person, reporting to the Secretary, whose primary reason for being there is to look after the business and the affairs of the domestic uranium industry. There is no one in the total DOE organization any more that has any particular responsibility for the front end of this cycle, and as a consequence we can see the results of that lack of interest.

Again, we are very appreciative of this opportunity. I don't think we have talked to your subcommittee before, but we feel that what we have to offer in this total prospect is tremendously important in the long-term capability of the nuclear industry in this country. As a consequence we would be, of course, very happy to respond to any information you might need, or any questions or any other such thing.

[The prepared statement of Mr. Stevens follows:]

PREPARED STATEMENT OF BILL STEVENS

Madam Chairman, and members of the subcommittee. My name is Bill Stevens. I am the chairman of the Uranium Policy Council of the American Mining Congress and also the president of Quivira Mining Company, a subsidiary of Kerr-McGee Corporation. For the past 30 years, Kerr-McGee has been one of the largest producers of uranium in the nation. Our company was recently forced by economic conditions in the industry to shut down our remaining uranium operations. I sincerely appreciate this opportunity to testify on behalf of the American Mining Congress before this subcommittee.

The American Mining Congress (AMC) was founded in 1897. It encompasses (1) producers of most of America's metals, coal, uranium, and industrial and agricultural minerals; (2) manufacturers of mining and mineral processing machinery, equipment and supplies, and (3) financial institutions and engineering and consulting firms that serve the mining industry.

As its name suggests, the Uranium Policy Council is the body within AMC charged with representing its uranium producers. The council is composed of senior executives of AMC uranium-producing members.

Madam Chairman, the Uranium Policy Council supports measures that will foster a strong nuclear fuel industry in the United States. We believe that a strong and competitive enrichment program is unquestionably a key ingredient in the nation's requirement for secure nuclear fuel supplies. To this end, we appreciate and support your efforts to develop and incorporate technological advances into Department of Energy (DOE) enrichment programs.

Madam Chairman, I have one fundamental concern I wish to share with you this afternoon. My concern is that we, as a nation, have forgotten that our nuclear fuel industry includes a uranium supply industry as well as a uranium enrichment industry. In the long term, a strong and secure nuclear fuel industry, which is the cornerstone of the U.S. defense and commercial nuclear power programs, requires not only uranium enrichment capability, but also dependable uranium production capability. Because uranium enrichment facilities entirely dependent on foreign sources of uranium supply become useless in the event that foreign supplies are threatened, dependable nuclear fuel supplies cannot be assured without both of these vital elements--production and supply.

The possibility that the United States will become entirely dependent on foreign sources of uranium supply is no longer remote. Indeed, that possibility is becoming more and more of a reality with each passing day. Only six of some 24 domestic processing mills licensed in 1981 are still in operation, and the majority of these are operating intermittently at substantially reduced capacity. Over 90 percent of the workers in the industry--some 20,000 employees--have lost their jobs, and employment continues to fall.

Capital expenditures of U.S. producers declined from over $1 billion in 1980 to $36 million in 1983, in 1983 dollars.

published reports, during the last two months, three of the nation's leading uranium producers have written-off over a quarter of a billion dollars of investments in uranium properties. There is little, if any, exploration activity in the U.S. Finally, and most importantly, published reports indicate that production of uranium in the United States has plummeted from 43.7 million pounds in 1980 to an amount expected to be less than 10 million pounds in 1985. This represents only a fraction of the annual U.S. requirement of 30 million pounds. We would have to go back to the beginnings of the industry in the 1950s before we find production levels that low. In short, the domestic uranium production industry is in its worst condition since it began some 30 years ago, and its future appears even more bleak.

Historically, Congress has specifically recognized the importance of a viable domestic uranium supply industry to this country's energy and security needs. In 1964, Congress amended the Atomic Energy Act to ensure that the Atomic Energy Commission--today the Department of Energy--had both the responsibility and the authority to maintain a viable domestic industry. The Joint Committee on Atomic Energy, in assessing the purpose and effect of the legislation, observed that "the maintenance of a viable domestic uranium mining and milling industry is an essential part of a sound nuclear industry and is also vital to the long-range defense and security interest of the United States."

Today, the Department of Energy is following policies that fail to discharge its responsibility to safeguard and preserve the viability of the domestic nuclear industry. We believe that DOE's policies are directed toward maximizing the short-term benefits to the government while ignoring the immediate harmful effects on the domestic supply industry, which will have adverse effects on the long-term viability of this country's fuel capability. We feel strongly that DOE must have a plan for a stable, secure long-term source of uranium supply.

Madam Chairman, the situation of the domestic uranium industry should be of concern to this subcommittee, as well as to the Department of Energy because the loss of a viable domestic uranium industry will jeopardize the U.S. enrichment enterprise and the entire U.S. commercial nuclear power program.

An enrichment industry that becomes entirely dependent on foreign sources of uranium feed can hardly be considered to be a healthy, secure and competitive operation. Foreign supplies are subject to a host of political, military and commercial uncertainties. Witness the on-again, off-again positions of the Australian government. We cannot today foresee all the possible reasons that may cause foreign suppliers to be undependable or too expensive. The vast U.S. investment in enrichment facilities and new enrichment technology will be at risk if we allow our uranium supply industry to disappear.

Uranium production and enrichment capability outside the U.S. is dominated by foreign government-owned entities whose primary mission is to carry out each particular nation's nuclear policies. These policies often promote political, military or economic purposes not necessarily consistent with U.S. interests. The government of Canada, for example, has an upgrade-in-Canada policy. Under this policy, the Canadian government requires purchasers of Canadian uranium to have the uranium processed at facilities owned by the Canadian government. This situation already directly threatens the U.S. uranium conversion industry. The policy could easily be extended to require enrichment prior to exportation if Canada chose to build an enrichment facility. This is just one example. I am sure you are very aware of the problems DOE has already faced with enriched uranium suppliers of other nations. Only with secure and reliable sources of domestically produced uranium can we be assured of a viable U.S. enrichment industry.

DOE enrichment policies largely determine the viability of the domestic uranium industry. Previous DOE policies helped encourage the development of foreign enrichment facilities, now competitive with DOE, but have also created large stockpiles of both natural and enriched uranium. These stockpiles have seriously depressed DOE's enriched fuel market as well as the market served by the domestic uranium industry.

DOE's response to this market situation has been the marketing of its new Utility Services enrichment contract. We understand that revision of DOE's enrichment contracting was necessary; however, several aspects of the new enrichment contract will have a damaging effect on our industry.

The sudden relaxation of enrichment commitments has had a backlash on uranium suppliers upstream from DOE. Utilities purchasing uranium to meet their DOE commitments suddenly have greatly delayed uranium purchases. The DOE announcement did not allow a reasonable time for the uranium industry to adjust, and the market impact has been severe. Many involved in the nuclear fuel industry see this new contract as the final blow to an already seriously impaired U.S. uranium industry.

To take one example, the new contract unfairly penalizes U.S. uranium producers in order to hold down DOE's costs and increase DOE enrichment processing. It does this by limiting the range of tails assay that a DOE customer may select and by penalizing selections of enrichment tails assay above 0.20 percent U^{235}. We estimate that this decreases demand for uranium by approximately 5 million pounds per year--the output of several medium-sized uranium mills. In the meantime, we understand DOE has announced plans to operate its enrichment plants at a tails assay above 0.30 percent U^{235}. This so-called "split tails" or overfeeding of the enrichment plants will hold down DOE's electricity costs, but will result in the transfer of at least 50 million pounds of uranium concentrate equivalent from the national uranium stockpile into the commercial market.

The effect on the uranium industry is to transfer uranium demand from private producers to the government. We are literally losing our market as a result of DOE's actions, and these sales opportunities are desperately needed by our industry.

Despite the significant impact of the new enrichment contract on our industry, the U.S. uranium industry was excluded from its development and formulation. Thus, the U.S. uranium supply industry had no voice in the preparation of DOE policies that largely will determine its course for years to come. A recent report by the General Accounting Office has also expressed this concern about the exclusion of interested parties outside the utility industry from DOE's policy process.

DOE's enrichment enterprise has always held a position of tremendous market power with respect to the domestic uranium supply industry. The Department of Energy and the nation's electric utilities are regulated and operated in such a manner as to guarantee recovery of reasonable costs and to assure their continued viability. The domestic uranium industry, hammered by foreign imports and excess inventories, has no such government direction and is completely dependent on the market conditions created by DOE, foreign government and electric utility actions.

Madam Chairman, we do not believe that Congress intended DOE's business enterprise to be conducted without due regard to adverse impacts on U.S. uranium producers. Indeed, the Atomic Energy Act requires DOE to "assure the maintenance of a viable domestic uranium industry" in the conduct of its enrichment operations.

We believe that DOE must take these statutory obligations into account in framing its enrichment policies. We believe that it is for the good of the country that DOE do so, for the statutory provisions were adopted to assure that the United States retain a viable uranium industry and guarantee secure supplies of fuel for our nation's commercial nuclear program. DOE's enrichment technology and capability are an essential part of assured energy supplies for the U.S.--but it is not the whole story. Equally important is a U.S. uranium industry capable of providing secure supplies of uranium for further enrichment and processing into fuel. We ask you today to consider all elements of the fuel cycle in making far-reaching decisions regarding DOE enrichment plans and operations. Our very livelihood and the energy and military security of the U.S. are dependent on your decisions.

In conlusion, as stated in its Declaration of Policy, AMC supports "[p]ositive governmental policies for the domestic development of nuclear energy, recognizing its necessity and benefits, and governmental support for a viable domestic uranium-producing industry." The Department of Energy's enrichment program and the nation's uranium mining and milling industry are both equally important to the long-term well being of the domestic nuclear industry. We ask only that the effects of DOE's enrichment program on our industry be considered and taken into account by DOE to assure a viable domestic uranium industry as otherwise required by law.

To that end, AMC recommends the following. First, DOE should alter its enrichment policy to encourage utility use of domestic uranium at the earliest reasonable opportunity. Specifically, DOE should:

- adopt a variable tails assay option to at least a 0.35 percent tail without surcharge for those utilities supplying domestic feed;

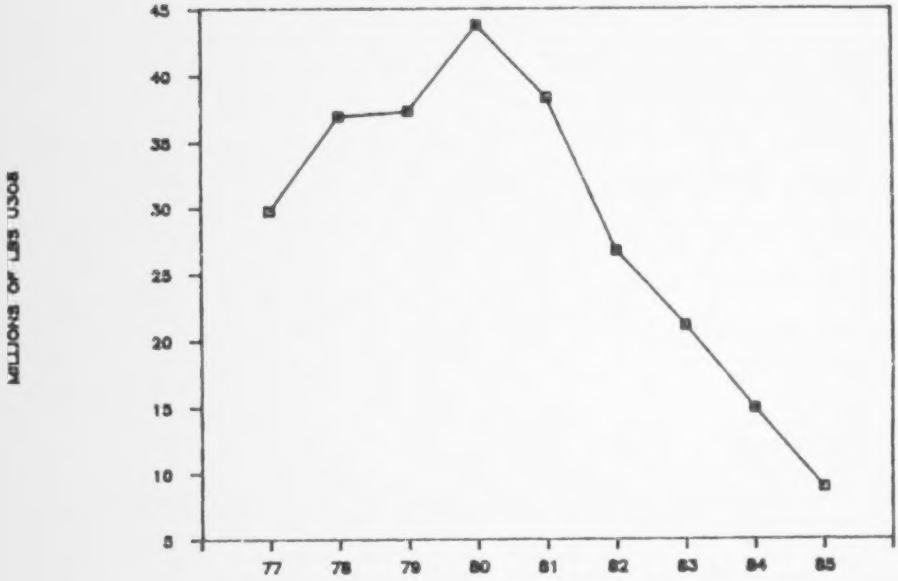
- initiate marginal pricing for enrichment services above 70 percent of requirements to those utilities using domestic feed, and

- meet supplemental feed requirements from the domestic industry if DOE plants are operated in a split tailings mode.

Second, to assure that the interests of the domestic uranium mining and milling industry are considered by the department, it is imperative that a high-level official, outside DOE's enrichment program and reporting directly to the Secretary, be designated as responsible for uranium industry matters.

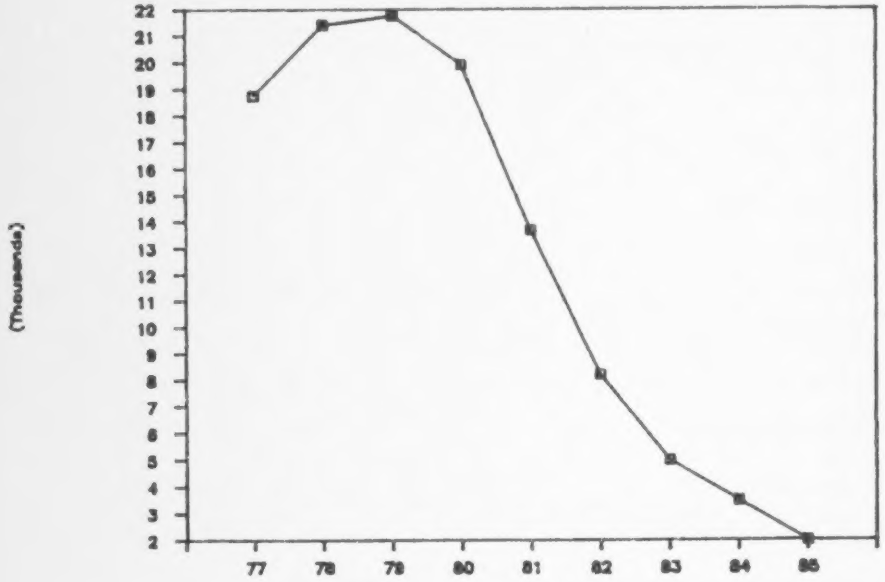
Madam Chairman, I have appreciated this opportunity to testify before the subcommittee. Members of the AMC Uranium Policy Council would be delighted to meet with you and other members of the subcommittee to discuss these issues further. AMC would also sincerely welcome the mediation and assistance of you and your subcommittee in addressing and resolving the issues that we have identified. Thank you.

U.S. URANIUM PRODUCTION

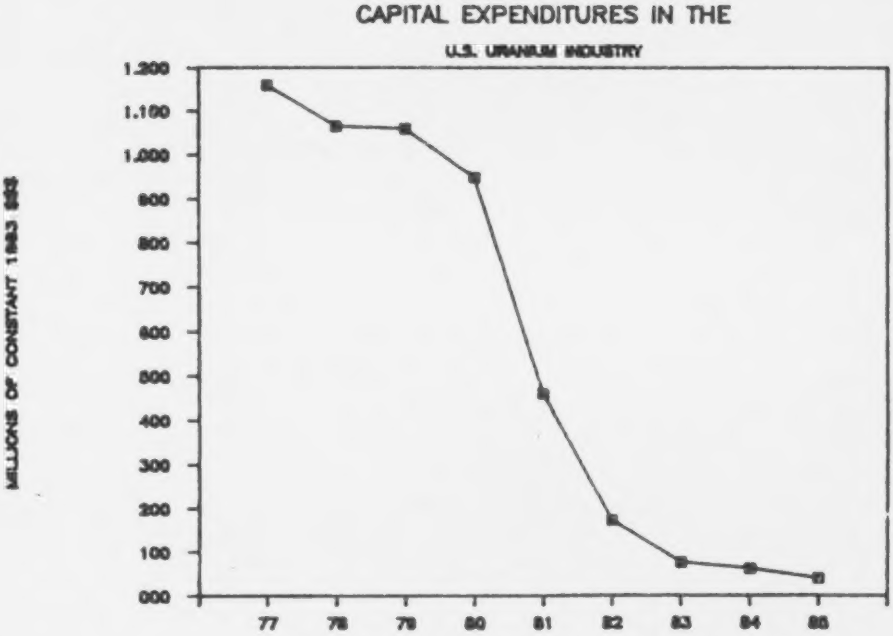


Source: U.S. DOE, Industry Estimates

U.S. URANIUM INDUSTRY EMPLOYMENT



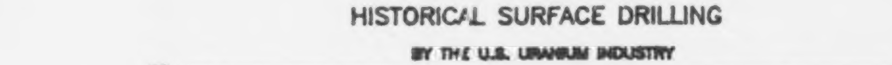
Source: U.S. DOE, Industry Estimates



CAPITAL EXPENDITURES IN THE

U.S. URANIUM INDUSTRY

Source: U.S. DOE, Industry Estimates



HISTORICAL SURFACE DRILLING

BY THE U.S. URANIUM INDUSTRY

Source: U.S. DOE, Industry Estimates

Mrs. LLOYD. Thank you very much, Mr. Stevens. We will have additional questions we will submit to you in writing that you can reply to for the record.

If the Congress did not support measures to prop up the domestic industry, would it totally collapse? Do you think that you are at the verge of collapse?

Mr. STEVENS. Yes, ma'am, very definitely so, and I say that simply because there is such a small percent of the capability being used these days, that most of the investment in the uranium industry has either been washed away or written off, or companies are trying to sell their facilities. Nobody wants to buy them.

Most of the uranium mining is such a thing, and the facilities themselves, that they are not going to wait around. They will not be there. They will be gone when the time comes, which hopefully it will come.[1]

Mrs. LLOYD. Well, how long does it take to open up a pit or underground mine after it has been shut down for a number of years?

Mr. STEVENS. That varies, Madam Chairman, and it varies from perhaps just a very short period of time to never opening it up again. The ground conditions of a uranium mine are very, very bad, and they cave in and cave shut and this sort of thing.

I think another aspect of a private industry maintaining uranium mines is the aspect that most uranium is found in aquifers that have a tremendous amount of water in the formations. They require pumping to keep the mine open. This is a very large expense, and in most instances after some period of time—and of course this varies from company to company—they can't afford to pump and maintain a mine, so they let it flood. When that happens, in most instances that mine will be lost.

Mrs. LLOYD. Do you support the advanced uranium enrichment technology programs we have discussed today?

Mr. STEVENS. Oh, yes, we certainly do. We think that this country needs to become not only competitive but be in the forefront of the enrichment capability in this world.

Mrs. LLOYD. Will any of the changes that you want DOE to implement in the management of the Enrichment Program result in higher costs to the enrichment services, the programs that you outlined, proposals?

Mr. STEVENS. I don't know, Madam Chairman. Certainly some aspects of it could result in higher cost but the overall thing could be, the overall cost of nuclear fuel could be less because the aspect of depending on foreign products may be very attractive for a period of time, but our experience really hasn't been too good at that over the long haul. Certainly there are foreign sources of uranium that can produce uranium cheaper than domestic producers can, but if we had the opportunity to a truly free world market, the domestic industry could compete. They wouldn't get all the sales. They couldn't handle all the sales, in the first place, but there is room for a good, strong domestic capability in development of uranium for particularly this country's nuclear program.

Mrs. Lloyd. Well, thank you. I certainly appreciate your testimony, and to all of our witnesses we again say thank you. We appreciate your help in our hearings as we deliberate to come up with a responsive program budget proposal for approval as we mark up our bill at the end of next month.

The subcommittee will meet again on Monday, March 4, at 1 o'clock, in room 2318, this room, to hear from NRC and other non-DOE witnesses on the Nuclear Waste Management Program. Thank you. The subcommittee stands adjourned.

[Whereupon, at 5:35 p.m., the subcommittee adjourned, to reconvene at 8:35 a.m., Tuesday, March 5, 1985, in room 2337, Rayburn House Office Building.]

1986 DEPARTMENT OF ENERGY AUTHORIZATION

TUESDAY, MARCH 5, 1985

House of Representatives,
Committee on Science and Technology,
Subcommittee on Energy Research and Production,
Washington, DC.

The subcommittee met, pursuant to recess, at 8:35 a.m., in room 2337, Rayburn House Office Building, Hon. Marilyn Lloyd (chairman of the committee) presiding.

Present: Representatives Lloyd, Stallings, Morrison and Fawell.

Mrs. Lloyd. The Subcommittee on Energy Research and Production will come to order.

Good morning, ladies and gentlemen. The pair of hearings which conclude today involve a most important issue; that is, no less than the question of the future of the United States uranium enrichment enterprise.

I have identified four areas of principal concern which have emerged from our subcommittee's oversight on the Uranium Enrichment Program. I delineated these four critical areas in last week's ERP hearing with outside witnesses. They are as follows:

One, the technology selection between AVLIS—atomic vapor laser isotope separation—and the advanced gas centrifuge—AGC—and the associated development schedule.

Two, the operation of the gaseous diffusion plants in a cost-effective manner and mechanisms for reducing the DOE cost of electricity.

Three, the modified deployment plan for the gas centrifuge enrichment plant and the manner in which the Department intends to implement the plan.

Four, the decisionmaking process on the part of DOE and whether they have indeed made a good-faith effort to conduct the enterprise in a businesslike manner despite some major administrative constraints.

Now, beyond these obvious programmatic issues and the related business decisions of the enterprise, there are larger policy issues which challenge the Department of Energy. I will repeat them today.

The first of these is: What actions can the United States take to assure other countries that we again intend to prove ourselves a reliable supplier of enrichment services? I believe that the decisions taken with respect to the enterprise will answer some of in-

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dustry's questions today about the relative certainty of any Federal nuclear policy.

For instance, does the Federal Government weigh the great investment in funding and people which companies have committed over the long haul to develop a reliable supplier infrastructure, or will decisions be based solely on near-term budgetary aspects?

Further, can the Federal Government successfully operate a business which must be geared to meet intensive competition in the modern international market?

And, finally, the administration must also answer the question as to whether the Federal Government can carefully and responsibly diminish its presence in certain areas of the country rather than stealing away into the night, thus wreaking great socioeconomic havoc?

There is no more challenging budget and oversight matter for this subcommittee than the decisions affecting the future of the uranium enrichment enterprise. We must approach this complex decisionmaking process with open minds and great care, as I reminded Secretary Herrington in a letter last month.

It is no exaggeration to claim that calendar year 1985 will mark the major turning point for the future of the United States uranium enrichment enterprise. Let us all hope and pray that all those involved, inside and outside of DOE, are capable of making the right choices.

Today we hear from the Department of Energy. We have Mr. James Vaughan, who is the Acting Assistant Secretary for Nuclear Energy, who is accompanied by Mr. John Longenecker, the Deputy Assistant Secretary for Uranium Enrichment.

Mr. Vaughan, we welcome you. Your complete written statement will be included in the record. We are also glad to have you with us, John. I hope you will bear in mind that your complete statement will be included in the record, so that you may summarize as you wish.

Mr. Vaughan, we also recognize that you have to leave at 9:30 a.m. to go to another hearing, so we will dismiss you at that time. Please proceed.

STATEMENTS OF JAMES W. VAUGHAN, JR., ACTING ASSISTANT SECRETARY FOR NUCLEAR ENERGY, DEPARTMENT OF ENERGY; AND JOHN R. LONGENECKER, DEPUTY ASSISTANT SECRETARY FOR URANIUM ENRICHMENT

Mr. **Vaughan**. Thank you very much, Madam Chairman and members of the subcommittee.

I am pleased to be here again today, this time to talk about our Uranium Enrichment Program. I will try to focus on the major elements of the Department's production and business strategy, including our plans for advanced technology selection and deployment, and I will, as we talk this morning, attempt to address a number of the topics that you outlined of concern in your opening statement.

As you know, our funding request for the Uranium Enrichment Program in fiscal year 1986 is approximately $1.6 billion in budget authority, which is fully offset by $1.6 billion in projected revenue.

The funds are distributed among the elements of the program as shown on the first page of our prepared statement.

This fiscal year 1986 congressional budget for uranium enrichment has been prepared in advance of a number of our key program decisions which we have targeted for this spring. Therefore, while the budget details may require some revisions after our technology selection, production, and business strategy decisions have been made, we do believe that the key program objectives can be satisfied within a net zero appropriation for fiscal year 1986.

As you know, in January 1984 we did announce our new business strategy and released the utility services contract to our customers. Slightly more than 90 percent of DOE's previous sales base converted to the U.S. contract, and the results of the contract conversion are a good start in supporting our efforts to improve the financial condition of the enrichment enterprise. We plan to continue these efforts, and by further reducing costs, we believe we will be able to pass price savings on to our customers while we still fully recover costs as we are required to do by law.

Turning to the matter of the gaseous diffusion plant operations, we did continue operations in 1984 at all three of our gaseous diffusion plants and made some good progress in enhancing the overall economy of their operation.

We managed to shift production between plants to the source of cheapest power and were therefore able to reduce the average cost of energy used to produce each separative work unit by more than 10 percent during 1984.

As you all recognize from our budget, the cost of electric power is the most significant expense in running this enterprise. Our contractors from whom you heard last week have made some good efforts in identifying alternative operating modes for the GDP's that have further enhanced their operating efficiency.

We have begun to make better use of offpeak power at the GDP's, and we hope that further savings can be achieved. We utilized this mode at Portsmouth last year and plan to use it at Paducah and Oak Ridge in 1985. Our overall objective is clearly to assure that we can operate these gaseous diffusion plants in the most cost-effective manner during the remainder of their useful life.

Turning now to the subject of the advanced technologies, as you are indeed well aware, a very intensive, technical, and economic evaluation of the advanced gas centrifuge and atomic vapor laser isotope separation, AVLIS, technologies were initiated. A Process Evaluation Board named by former Secretary Hodel in June 1984 began an exhaustive review of basic technology, estimated plant costs and schedules, and other related factors.

The contractors are on track to generate the remaining data required for a technology selection in May 1985. It is our intent at that time to select the most promising technology for further development, including life cycle and reliability testing.

It is very important to note, and to clarify some confusion that has existed, that additional development work on the technology selected will be necessary to confirm process performance and economics and to determine an optimum deployment schedule. This further development is really inherent in moving the technology selection date from 1987 to 1985, as we did last year, for we clearly must ensure technical adequacy before committing to a deployment.

Both of the technologies have indicated good technical and economic soundness and the potential for assuring that we can remain in a position of international competitiveness in the long term if we make our business and technical choices wisely.

It has also been interesting to note that the very effort going on in the advanced technology competition has been one of the factors that has provided a stimulus for the operators of the gaseous diffusion plants to find more innovative and imaginative ways to keep their costs down, so we have gained a near-term benefit in that regard.

The construction of the gas centrifuge enrichment plant—the so-called GCEP project—utilizing Set III machines was continued in 1984 but at a slower pace. The project slowdown was a choice we made and effected to assure that our investment prior to a final technology selection will be minimized and that the GCEP design can be thoroughly evaluated in the context of the Set V technology.

This reevaluation was really necessary to ensure that if the advanced gas centrifuge concept does win the technology selection in May, it could be incorporated into the enterprise in an economically optimum manner. Today, significant progress is being made toward beginning the experimental operation of that plant this April.

With respect to improving our capability to sell more separative work units both domestically and abroad and to capture a greater share of the market, we have intensified our efforts to improve our marketing and customer services in 1984. As any good business would do, I think we are doing a better job these days of listening to and learning from our customers' thoughts on how we might serve them better, and we have made a strong commitment to continue a reliable and responsive service to all of our customers.

We have made some real progress toward completing our overall strategic plan this spring that will help define the course that the enterprise should take in the long term to assure that we can not only make the most effective use of our resources but remain competitive. Although the contract conversion process is touted as having been very successful, we still only have about 47 percent of the world market, and we find that a substantial amount of customer requirements during the late 1980's and early 1990's remains uncommitted to any supplier.

For example, we estimate that 8 million SWU's are uncommitted in the 1987-90 timeframe, roughly 2 million SWU's per year, and we are currently developing means under the U.S. contract by which we will be able to compete for these uncommitted sales.

To summarize, 1984 was a year in which we continued the process of better matching our enterprise to the market, bringing our costs and prices down, and serving our customers better.

It is indeed our intention that the price of uranium enrichment services continue to decline in the future, and we hope to accomplish this through continuing effective management of the existing elements of the enterprise and by introducing advance technology when it is economically advantageous.

Targeting for May 1985, the final elements of our business strategy will be better defined, and even though our budget cycle is ahead of the schedule for finalizing our business plan, we have developed a budget which we believe encompasses all reasonable program options, and we would plan to submit additional details on any revisions to you in May.

It is also our intent that the May 1985 business strategy include a plan for some repayment of the Government's investment in the uranium enrichment enterprise, and we do believe at this time we will begin to be able to make some payments to the Treasury on the debt.

We do believe, Madam Chairman, that we have a well-structured process in place for making these crucial technical and business decisions that face the enterprise. As you commented in your opening statement, there is no question that 1985 is the crucial year for making crucial decisions that will guide our future direction.

This committee has been very supportive in the past. We appreciate your cooperation and support and look forward to continuing to work with you.

This completes my opening remarks.

[The prepared statement of Mr. Vaughan follows:]

STATEMENT OF
JAMES W. VAUGHAN, JR.
ACTING ASSISTANT SECRETARY FOR NUCLEAR ENERGY
DEPARTMENT OF ENERGY
BEFORE THE
SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

MARCH 5, 1985

Madam Chairman and Members of the Subcommittee, I am pleased to be here today to discuss the Department of Energy's Uranium Enrichment program. I will focus primarily on the major elements of the Department's production and business strategy, including our plans for advanced technology selection and deployment. Accompanying me is John R. Longenecker, the Deputy Assistant Secretary for Uranium Enrichment.

The Department's funding request for the Uranium Enrichment program in FY 1986 is approximately $1.6 billion in budget authority, which is fully offset by $1.6 billion in projected revenue. The funds requested are distributed among the major elements of the program as follows:

Program Element	FY 1986 ($ in Millions)
Uranium Enrichment Activities	
Power	$ 884.0
Enrichment Research and Development	150.0
Gas Centrifuge Enrichment Plant	340.0
All Other	238.7
Total Expenditures	1,612.7
Uranium Enrichment Revenues	- 1,612.7
Net Appropriation	$ 0

The FY 1986 Congressional budget for Uranium Enrichment has been prepared in advance of a number of key program decisions, which are targeted for this spring. While the budget details may require some revisions after the technology selection, production, and business strategy decisions have been made, we believe that the key program objectives can be satisfied within a net zero appropriation for FY 1986. We expect to present additional detail on our budget request in May 1985. -

In January 1984, we announced our new business strategy and released the Utility Services (US) contract to our customers. Response to the US contract has been positive, and we appreciate the good-faith efforts of all our customers in negotiating conversions to the US contract. Slightly more than 90 percent of DOE's previous sales base converted to the US contract. The results of the contract conversion strongly support DOE efforts to improve the financial condition of the enrichment enterprise. We plan to continue these efforts. By further reducing costs, we can continue to pass price savings on to our customers while fully recovering costs.

We continued enrichment operations at our three gaseous diffusion plants (GDPs) in 1984 and made significant progress in enhancing the overall economy of their operation. By shifting production to the source of cheapest power, we were able to reduce the average cost of the energy used to produce each separative work unit (SWU) by more than 10 percent during FY 1984. Through some very dedicated work on the part of Martin Marietta, Goodyear, and the Department, we have been able to identify alternative operating modes for the GDPs that have further enhanced their operating efficiency.

By using off-peak power at the GDPs, we predict that further significant savings can be achieved. Off-peak power was utilized in the GDP at Portsmouth, Ohio, through much of 1984 and will be utilized at the GDPs in Paducah, Kentucky, and Oak Ridge, Tennessee, in 1985. All of these efforts were undertaken to assure that operating costs will be reduced, that near-term prices will decline as rapidly as possible, and that the GDPs will be operated in the most cost-effective manner possible during the remainder of their useful life.

During 1984, an intensive technical and economic evaluation of the Advanced Gas Centrifuge (AGC) and the Atomic Vapor Laser Isotope Separation (AVLIS) technologies was initiated. A Process Evaluation Board (PEB), chaired by Peter Johnson of the Bonneville Power Administration, was named by then Secretary Hodel in June 1984. Since June, exhaustive reviews of basic technology, estimated plant costs and schedules, and other related factors have been evaluated by the PEB. The AGC and AVLIS contractors have accomplished things that few would have thought possible a year ago, and both are on track to generate the remaining data required for a technology selection in May 1985. In May 1985, DOE will select the most promising technology for further development, including life cycle and reliability testing. It is important to note that additional development work on the technology selected will be necessary to confirm process performance and economics and to determine an optimum deployment schedule. This further development is inherent in moving the technology selection date from 1987 to 1985; we must ensure technical adequacy before committing to a deployment.

Both the AGC and AVLIS technologies have indicated technical and economic soundness and the potential for assuring that the United States will maintain a position of international competitiveness in the long term. Also, since the new technology that will be selected must better the production costs of the gaseous diffusion process, the technology competition has provided added impetus to efforts to further reduce GDP costs. This has stimulated significant improvements in GDP economics that will aid our near-term competitiveness and contribute to the development of sound advanced technology concepts for future use.

Construction of the Gas Centrifuge Enrichment Plant (GCEP) project, utilizing Set III machines, was continued in 1984, although at a slower pace. Procurement of Set III machines from the three manufacturers is continuing. The project slowdown was effected to assure that our investment prior to a final technology selection will be minimized, and that the GCEP design can be thoroughly evaluated in the context of the Set V technology. The reevaluation of the GCEP design was necessary to assure that if the AGC concept wins the technology selection in May 1985, it can be incorporated into the enterprise in an economically optimum manner. A significant project accomplishment in 1984 was the completion of the installation of the first cascade of Set III centrifuges in March. Today, significant progress is being made toward the beginning of experimental operation of the plant in April 1985.

We intensified our efforts to improve marketing and customer service in 1984. We are committed to serving our customers better, communicating with them more effectively, and conducting the enterprise in a competitive manner on a continuing basis. As any good business would do, we are still listening to and learning from our customers' thoughts on how we might serve them better, and we have a strong commitment to continue reliable, responsive service to all of our customers. Also, we have made significant progress in the development of a strategic plan that will define the course that the uranium enrichment enterprise should take in the long term to assure that we will make the most effective use of our resources and will remain competitive.

Although the contract conversion process was very successful, we find that a substantial amount of customer requirements during the late 1980's and early 1990's remains uncommitted to any supplier. Specifically, we estimate that approximately 8 million SWUs are uncommitted in the 1987-90 time frame. The Department currently is developing means under the US contract by which we will be able to compete for those sales. Better utilization of our existing GDP capacity could lower average production costs and increase our sales volume.

In summation, 1984 was a year in which we continued the process of better matching the uranium enrichment enterprise to the market, bringing our costs and prices down, and serving our customers better. It was a good first step, but it was only a beginning. It is our intention that the price of enriched uranium continue to decline in the future. We will do this through effective management of the existing elements of the enterprise and by introducing advanced technology when it is economically advantageous.

In May 1985, the final elements of our business plan will be well defined. Even though the budget cycle is ahead of our schedule for finalizing our business plan, we have developed a budget for FY 1986 which we believe encompasses all reasonable program options. Additional details on the budget will be submitted in May 1985 and will reflect the impact of advanced technology selection and related production decisions. Also, the May 1985 business strategy will include a plan for replacement of the Government's investment in the uranium enrichment enterprise. At present, it is estimated that the uranium enrichment program will begin to make payments to the U.S. Treasury in FY 1986. The specific amount of the payments will be designated when additional budget details are forwarded in May 1985.

We believe that we have a well-structured process in place for making the crucial technical and business decisions that face the enterprise. We ask for your support in seeing this process through to completion, and we expect to be discussing its results with you in a few months. Implementation of our business strategy will be a multiple-year undertaking, but we have set the course and are prepared year-by-year to make the tough decisions that will be required to achieve our competitive goals. We thank you for your cooperation and support in the past, and we look forward to working with you in the future.

Madam Chairman, this completes my formal statement. With your permission, Mr. Longenecker will elaborate on some key items that are covered in a more detailed statement. I would like to submit that statement for the record. We would be pleased to respond to any questions that you may have during or following Mr. Longenecker's comments.

ATTACHMENT FOR THE RECORD
DETAILED STATEMENT OF
JAMES W. VAUGHAN, JR.

FEBRUARY 27, 1985

INTRODUCTION

The Administration believes that fundamental changes in the character of the U.S. uranium enrichment enterprise are required for the marketplace of the 1980's and 1990's. The market has changed significantly since the commercial enrichment program was established in the early 1960's, and DOE must update its national enrichment policies and programs if the enterprise is to be competitive now and in the future. The current world market for enrichment services is characterized by oversupply, low growth, and fierce competition from foreign commercial firms.

The Nation's domestic and foreign policy interests are best served if a competitive, indigenous uranium enrichment capability is maintained. By doing so, DOE can maintain an economical and secure source of fuel for a major portion of the Nation's electrical generating capacity and help ensure national security. Further, the United States can increase its opportunity for a favorable balance of trade and for accomplishing its nuclear nonproliferation objectives.

The Department is taking a systematic approach to the development of a comprehensive business strategy for future enrichment operations. This process progresses logically as follows:

1. Establishment of goals and objectives for the uranium enrichment enterprise
2. Realistic assessment of the marketplace and identification of problems
3. Optimization of production alternatives and economics to meet demand
4. Optimization of finance and business methods to support the enterprise.

During FY 1984 and FY 1985, we focused primarily on the first two steps of the process and established the mechanisms and schedule for completion of the remaining steps. Based on the objectives established by the Department for the enrichment enterprise, the Utility Services contract was issued in January 1984 to help stabilize the market and establish a reliable estimate of the future demand for enrichment. The Department also announced a revision to the approach for selection between advanced technologies and accelerated the selection date to May 1985. Finally, actions were initiated to evaluate the potential for future private-sector interest and participation in the enterprise.

Those actions were directed toward establishing a firm financial base for the enrichment enterprise and assuring that investment decisions can be made in a sound, businesslike manner consistent with cost recovery requirements. Development of an enrichment strategy is progressing well and remains on schedule for completion in May 1985. Every effort is being made to complete the remaining tasks on schedule and to assure that vital decisions during the months ahead will be based on the best information and the most reliable analytical techniques available. FY 1985 will be an important decision year for the U.S. enrichment business.

BACKGROUND

In prior years, in our testimony to this and other Committees, the Department has provided a description of the complex and interrelated problems that have impaired earlier attempts by DOE to serve as a reliable, competitive supplier of enriched uranium. Over the past several years, the DOE share of the world market for uranium enrichment has dropped significantly, from approximately 100 percent in 1974 to approximately 47 percent today. DOE's share of the non-U.S. market has declined from approximately 100 percent in 1974 to approximately 32 percent today. The success of our competitors in eroding our market is clearly depicted in Figures 1 and 2. A worldwide glut of enriched uranium, the emergence of a secondary market for enriched uranium at depressed prices, pricing by our competitors at discounts from DOE prices, and the drastic change in currency exchange rates (see Figure 3) adversely affected our ability to compete with other suppliers. Figure 4 shows that DOE has gone from a position of being the lowest-price to being the highest-price supplier over the past 4 years. In 1983, DOE analyzed this situation and developed a modified strategy to improve our market position. The purpose of the revised strategy was to stabilize DOE's market share by providing for an orderly reduction of excess inventories of enriched uranium and to stem the tide of customers turning to lower-price suppliers for their enrichment services.

OVERALL OBJECTIVES

The overall objectives of the Department's enrichment strategy are to be responsive to the needs of our customers; to be a reliable long-term supplier at predictable prices; to offer enriched uranium at the lowest reasonable price, based on sound business practices; and to operate the enrichment complex in a businesslike manner without Federal subsidy. To achieve these objectives, a market-driven approach was taken in the offering of the new Utility Services contract on January 18, 1984.

UTILITY SERVICES CONTRACT AND CONVERSION

The key elements of the new contract are:

1. Shorter leadtimes (180 days) for firming up deliv quantities

2. Ability to offset a portion of requirements by purchase from the secondary market

3. Ability to purchase a portion of requirements from foreign sources

4. A competitive price for separative work in both the near and long term, with price protection via a price ceiling

5. Flexibility to select a variable tails assay option, thus permitting customers to optimize fuel economics while increasing their purchases of natural uranium

6. Flexibility to terminate the contract with 10 years advance notice, with no penalty.

Overall, the new contract offered significant advantages to all our existing customers and to prospective new customers. Conversions to the new contracts were individually negotiated with each customer, to reflect the unique conditions affecting various customers. Those who held Fixed Commitment contracts obtained the ability to convert to a more flexible contract and to adjust their existing contractual commitments, in order to work off excess inventories. Customers holding Requirements contracts obtained a lower price from DOE and the ability to purchase a portion of their needs from the secondary market, potentially at an even lower price. Also, Requirements customers obtained access to the variable tails assay option, improving their ability to minimize fuel costs while providing for increased sales by uranium producers.

Customer response to the new contract has provided a firm base for future planning. As shown in Figure 5, customers representing slightly more than 90 percent of DOE's sales base converted their existing contracts to Utility Services contracts for at least 70 percent of their requirements. The Department believes this response indicates that the new contract met the needs of its customers. Most importantly, with the new contract in place, DOE has centered its strategy around the objective of satisfying a realistic demand for enriched uranium, and thus can match its production plans to the actual demands of the marketplace. The customer response to the new contract provides a more reliable basis for decisions involving future utilization of DOE production capacity, purchases of power for the gaseous diffusion plants, and the timing of phaseouts of existing capacity and the introduction of more cost-effective advanced enrichment technologies. Figure 6 shows the projected demand for enriched uranium as defined by the new Utility Services contract.

All key program decisions will be driven by the demands of the marketplace. The scope and pace of research and development activities and decisions to add new capacity will be based on reactions from the marketplace, including acceptance of the new contract, trends of price competition, and the actions of our competitors. In the near term, the strategy includes a commitment to develop and deploy enrichment technology when economically feasible -- that is, when they have demonstrated marginal costs below those of the existing gaseous diffusion plants. The funding level and the pace of these programs will be based on a businesslike approach that will be determined by market share, the availability of revenues, and the potential of advanced technology to lower costs.

The enrichment market is expected to remain extremely competitive throughout the next decade. Foreign suppliers of enriched uranium, such as Eurodif and URENCO, are aggressively competing for all uncommitted enrichment demand at prices significantly below DOE pricing levels. These suppliers are helped by the favorable currency exchange rates, the supply diversification strategies of many customers, and other factors.

The Utility Services enrichment contract provides the flexibility for customers to select a purchase commitment from DOE for any percentage between a minimum of 70 and a maximum of 100 percent of their total enrichment requirements for the first 5 years. Each year, customers exercise the option to select a new percentage within the 70 to 100 percent range for the coming 6th year. As a result, DOE's only assurance of a firm market in the future is the minimum 70 percent purchase obligation under the Utility Services contract. Today's average percentage purchase is approximately 75 percent. The remaining percentage represents uncommitted demand for which DOE must compete with other enrichment suppliers. As shown in Figures 7 and 8, based on projections of firm commitments to DOE under the Utility Services contract and firm obligations to foreign suppliers, the future market share for DOE is estimated to be 41 percent of the world market and approximately 25 percent of the foreign market.

CONTROL OF PROGRAM COSTS AND CUSTOMER PRICES

A primary focus of DOE's effort to remain competitive in the marketplace for enriched uranium is the offering of favorable prices and flexible terms. The cornerstone of our near-term program is an effort to bring down the price of DOE enrichment and to maintain it at a competitive level. Over the past 15 years, DOE's enrichment prices have increased by a factor of about 5, as shown in Figure 9. Continuation of the previous strategy, with large outlays for gaseous diffusion plant operations, payment of demand charges to the Tennessee Valley Authority for power not purchased, construction of the gas centrifuge enrichment plant, and conduct of advanced research and development projects, would make it difficult to offer competitive prices to customers in the near term, and would not inspire a high level of confidence that DOE is serious about price stability or price reductions in the long term. Accordingly, DOE has undertaken a vigorous cost reduction program.

One key element of cost reduction involves the operation of existing production capacity. DOE and its contractors have been making vigorous attempts to obtain the lowest-cost power available, to reduce outlays for GDP operations, to minimize demand charge payments, and to operate the existing complex in the most efficient manner possible. Substantial progress has already been made in these areas. In FY 1984, DOE began purchasing lower cost off-peak power at the Portsmouth, Ohio, enrichment plant and redistributing production among the three operating enrichment sites to minimize production costs. As a result of this effort, DOE's average unit cost for power purchases in FY 1984 declined by more than 10 percent from the average FY 1983 cost. DOE is now purchasing cheaper forms of power for all three plants and expects to continue this practice, if it proves technically feasible, during the remainder of the fiscal year. Since the GDP costs serve as the economic target that must be bettered by the advanced technologies if they are to be considered for deployment, lower production costs can extend the economic life of the GDPs.

The DOE strategy includes a firm commitment to pursue effective cost control in both the near and the long term. This commitment is evidenced by the offer of a cost ceiling in the new contract. Savings in GDP operating costs today will continue to provide price benefits to customers for as many years as DOE relies on any of the GDPs for production.

TECHNOLOGY SELECTION

In the near term, DOE is conducting research and development on both the advanced gas centrifuge (AGC) and atomic vapor laser isotope separation (AVLIS) enrichment technologies. A detailed technical and economic evaluation of the two processes is underway. The objective of this evaluation is to assess the technical feasibility and economic potential of both advanced options. DOE's objective is to determine the relative merits of pursuing each technology through the demonstration and deployment stages. It is the DOE goal to be in a position to make a decision in May 1985 as to which technology should be pursued for further development, demonstration, and eventual deployment. The technology selection must be made in the context of a comprehensive business plan for the enrichment enterprise. The decision is an integral part of our business strategy and will be made with major emphasis on the business aspects of the issue~~. Further,~~ a sound selection can be made only if all the factors relevant to the business are accurately measured and assessed, including:

- Future operations of the gaseous diffusion plants, including eventual replacement by advanced technology
- Development plans and potential deployment scenarios for the advanced technology
- Plans for the completion or termination of the gas centrifuge enrichment plant (GCEP)
- Financial and pricing implications of technology selection and production plans, including appropriate changes, if any, that should be made
- Ability of the enrichment enterprise to respond to future changes in the market and to remain competitive.

The elements of the technology selection process are described in Figures 10 through 12.

FINANCING ALTERNATIVES

In the past, the feasibility of attracting private-sector participation and capital to the enrichment enterprise has been examined. Failure to implement programs to achieve private-sector participation has been due largely to several key obstacles, including the large financing requirements, long payback periods, and uncertainty regarding future Government actions. Since the last major effort (the Nuclear Fuel Assurance Act of 1975), new obstacles have arisen, including the decline in nuclear power growth and the emergence of fierce foreign competition.

Notwithstanding these developments, the advent of advanced technologies (AVLIS and AGC) offers unprecedented opportunity for some degree of private participation in the uranium enrichment enterprise. Both AGC and AVLIS promise manageable capital costs and payback period, economically attractive modular production, and highly competitive unit costs of production. In view of this promise, we have taken positive steps in the past year to operate the uranium enrichment enterprise in a more businesslike manner, consistent with a wide range of possible private participation initiatives, should interest in this opportunity develop in the future. During FY 1984, a Private Sector Financing Working Group was established. The charter of the group was twofold: (1) to establish an institutional and policy framework amenable to private involvement in uranium enrichment; and (2) to support the Process Evaluation Board (PEB) by identifying the advantages that private participation could bring to the optimal deployment of advanced enrichment technology. The Department's recommendations for possible private sector participation in the uranium enrichment enterprise in the long term will be addressed in the business plan to be completed in May 1985.

SUMMARY

In summary, activities under the Uranium Enrichment program in FY 1985 and FY 1986 reflect the new strategy that was adopted last year. The strategy is market-driven and relies heavily on proven business practices. Progress in revitalizing the enrichment enterprise and strengthening its business character has been positive. The Department will fulfill its commitments to the Congress and its customers to lower prices and remain competitive, and to operate in a businesslike manner.

The Department is committed to retaining a competitive position in the uranium enrichment business, in order to assure that domestic utilities will have a reliable, reasonably priced indigenous supply of fuel, and that defense requirements will be met. DOE also remains committed to satisfying the enrichment needs of foreign customers, in order to further our national commercial and nonproliferation objectives. DOE is committed to meeting the long-term needs of its customers, commensurate with their commitment to rely on DOE for enriched uranium. Continuation of this strategy will have significant benefits to DOE's utility customers, to their ratepayers, and to the Nation as a whole.

FIGURE 1

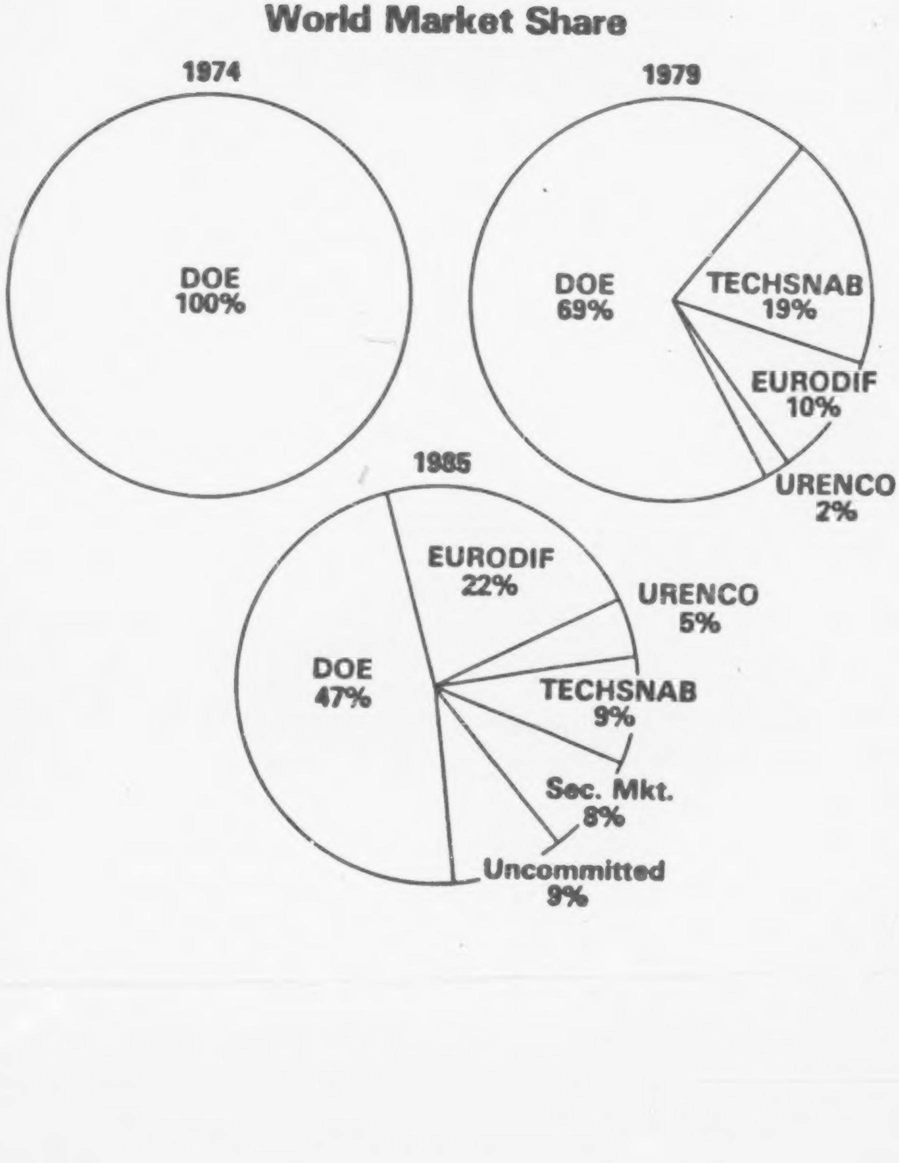
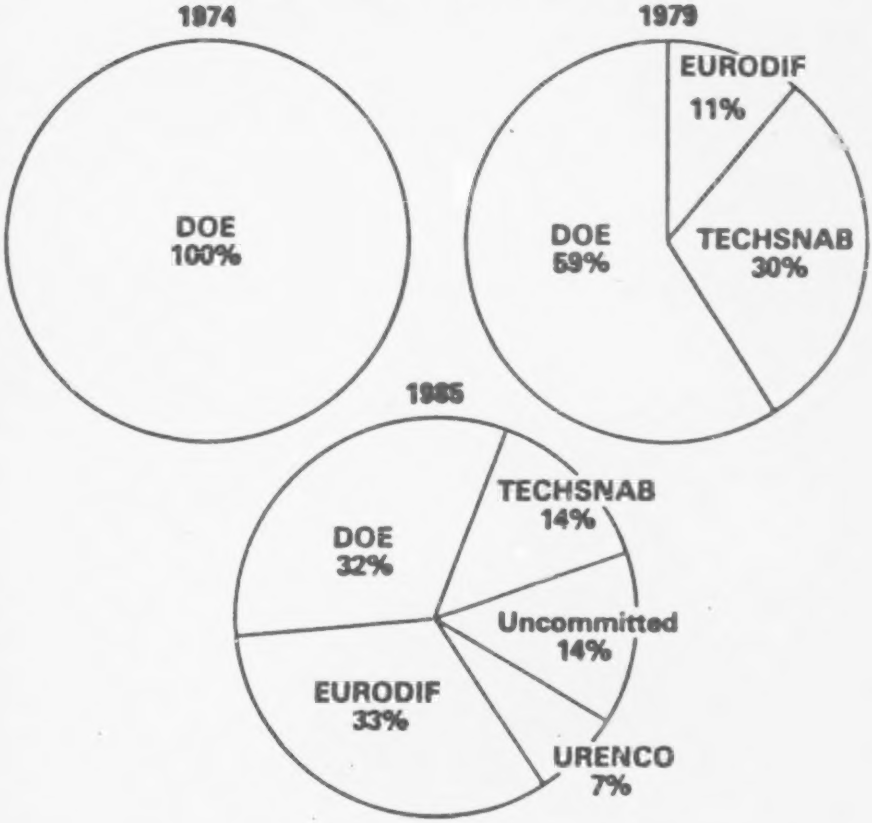

World Market Share
1974
DOE
100%
1979
DOE
69%
TECHSNAB
19%
EURODIF
10%
URENCO
2%
1985
EURODIF
22%
URENCO
5%
DOE
47%
TECHSNAB
9%
Sec. Mkt.
8%
Uncommitted
9%

FIGURE 2



Foreign Market Share

FIGURE 3

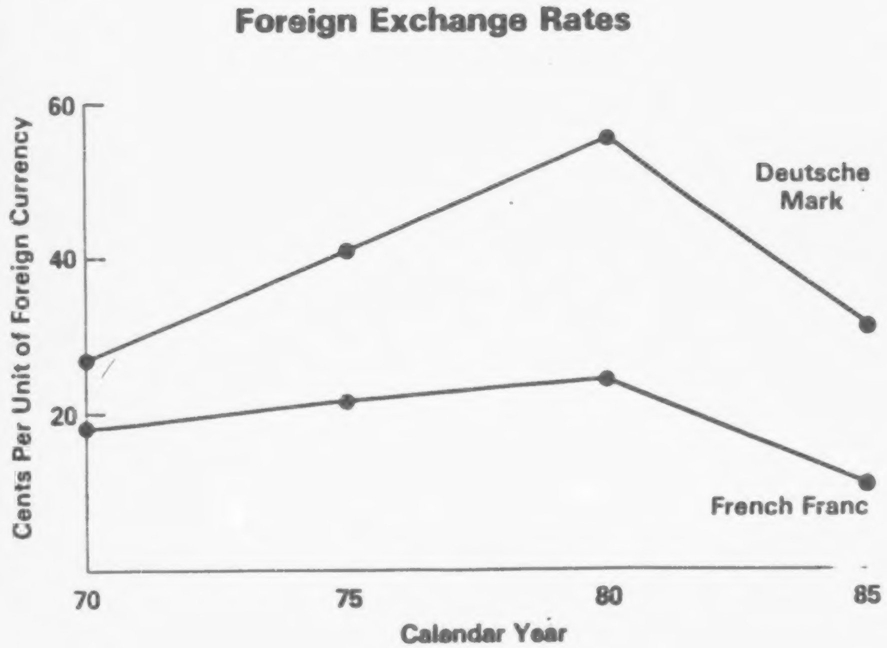

Foreign Exchange Rates
Cents Per Unit of Foreign Currency
60
40
20
Deutsche Mark
French Franc
70
75
80
85
Calendar Year

FIGURE 4

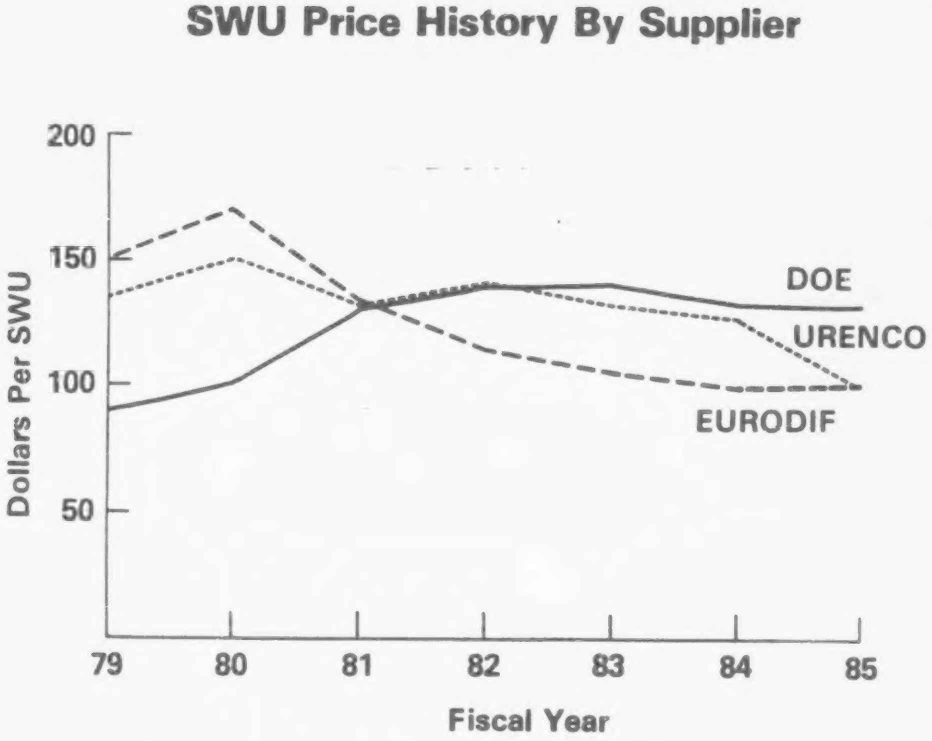

SWU Price History By Supplier
200
150
100
50
Dollars Per SWU
DOE
URENCO
EURODIF
79
80
81
82
83
84
85
Fiscal Year

FIGURE 5

Utility Services Contract Conversion By Market Area

	Before Conversion		Conversion Results	
Market Share	Total Number of Customers	Share of DOE Market (%)	No. Converted	% of Total DOE Market
United States	52	59.6	45	55.8
Far East ● Japan ● South Korea ● Taiwan	12	25.8	12	25.8
Europe ● Spain ● Netherlands ● FRG ● France ● Sweden ● Switzerland	18	12.4	11	6.8
Other ● Philippines ● Yugoslavia ● Egypt ● Mexico	4	2.2	4	2.2
TOTAL	86	100.0	72	90.6

FIGURE 4

Potential Demand on DOE Enrichment Complex

- 0.25% U-235 Tails Assay

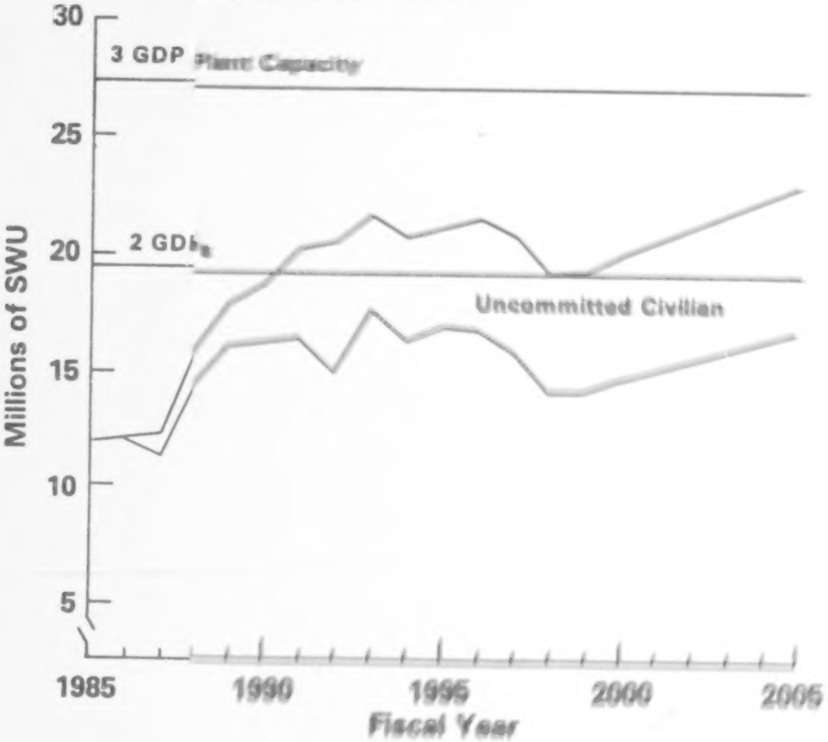


FIGURE 7

World Market Share

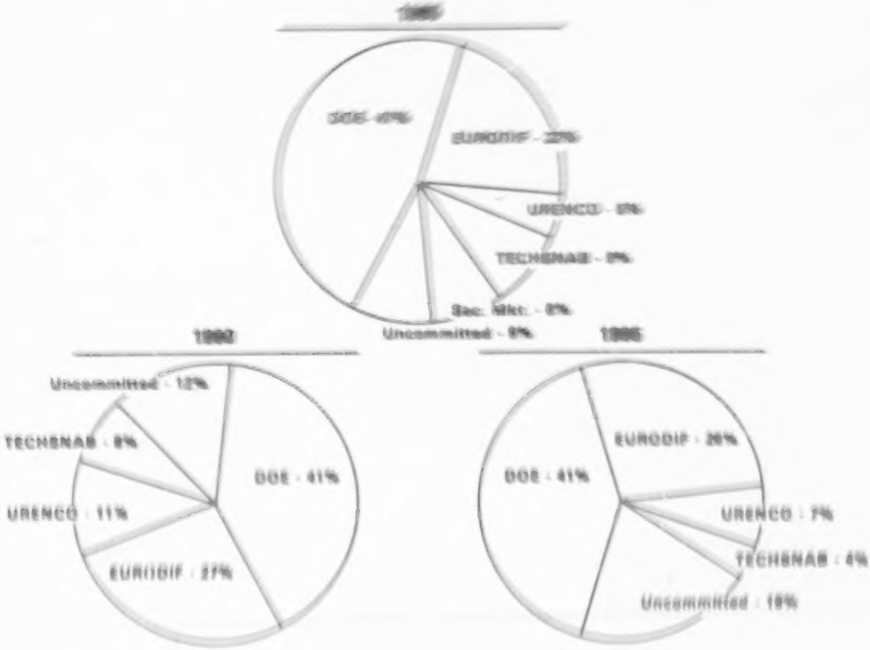


FIGURE 4

Foreign Market Share

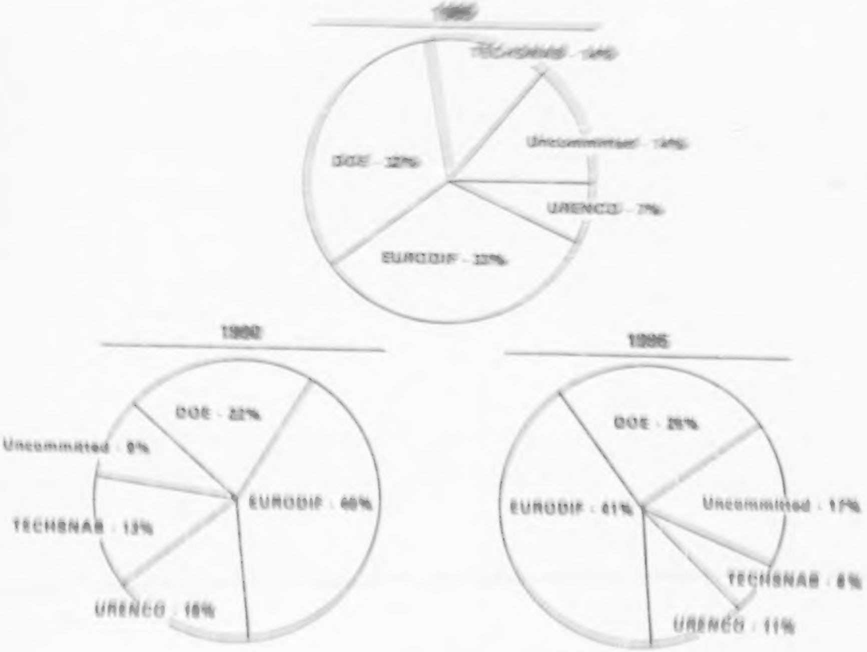
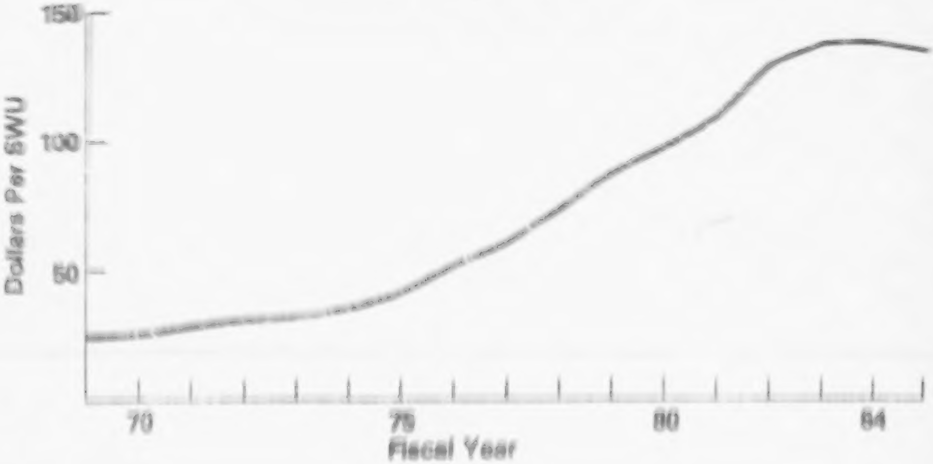


FIGURE 9



Historical Uranium Enrichment Service Charges

FIGURE 10

What We Mean by Selection in May of 1985

- Process Selection Will Choose the Technology for Further Development
- Neither AGC nor AVLIS Will Have Been Demonstrated at Production Scale by May 1985
- There Will Be Residual Technical & Economic Issues for Both Technologies

FIGURE 11

Tasks of the PEB

- Assess Status of Science & Technology of AGC & AVLIS Uranium Enrichment Processes
- Evaluate Cost & Economics of Uranium Enrichment for the Two Processes
- Assess Impact & Risks to Uranium Enrichment Enterprise of Different Production Deployment Scenarios

FIGURE 12

How Process Evaluation Works

- DOE Has Defined the Technical & Economic Data to Be Provided
- The PEB Has Defined the Initial Evaluation Criteria & Methodology, to Be Expanded if Needed as the Issues Are Better Defined
- The PEB Is Assisted by a "Peer Review" Process in Which Each Proponent Is Critiqued by the Other in the Presence of the PEB & in Writing
- Martin Marietta & Mitre Provide Support to the PEB on Economic Studies & Special Analyses on Issues Raised During Peer Review

Mr. VAUGHAN. With your permission, Mr. Longenecker will elaborate on some key items that are covered in the detailed statement. We will not go through it in its entirety by any means. I believe his comments will be responsive to some of the concerns you have expressed and some of the questions we have received in advance, and then we would be prepared to answer any questions that you all may have.

Mrs. LLOYD. Thank you, Mr. Vaughan.

Mr. Longenecker.

Mr. LONGENECKER. Madam Chairman, good morning.

We spoke with you last year about our belief that fundamental changes were necessary in the character of the total U.S. Uranium Enrichment Program if we were going to be able to compete in the international marketplace of the 1980's and 1990's.

We are now attempting to update our policies as well as our programs so that the enterprise can be competitive now and in the future. To put the current world marketplace for uranium enrichment services in context, it is still characterized today by oversupply, low growth, and fierce competition from our foreign competitors.

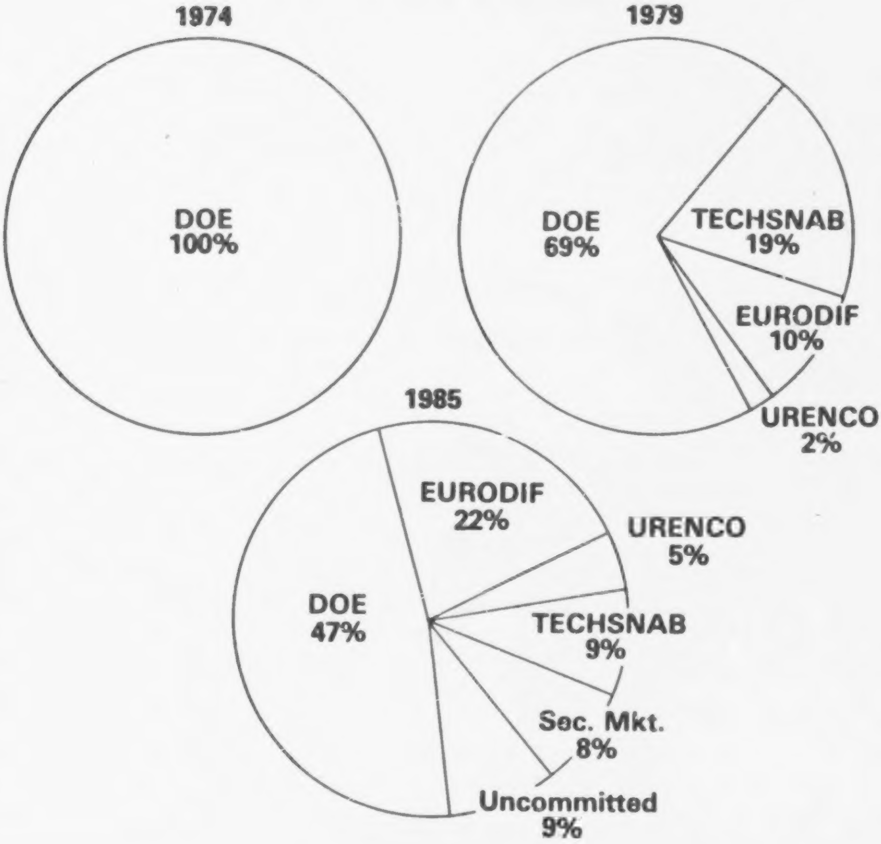
During 1984 and thus far in fiscal year 1985, we have focused primarily on the first two steps of realigning our policies to the marketplace; that was to establish clear, businesslike goals for the enterprise and to get a realistic assessment of the marketplace and identification of the business problems that would face us in the 1980's and 1990's.

I would reiterate your comment and Mr. Vaughan's that 1985 is a key decision year. What I would like to do this morning is provide you an update of the key market factors as we see them in 1985, because they do draw the boundaries of the constraints and other market factors that must be considered as we develop our revised business and technology strategy.

I have some transparencies I am going to use if we can get this set up, Madam Chairman.

[Chart.]

World Market Share



Mr. LONGENECKER. One of the key factors that we have to consider is world market share. In 1974 we were a monopoly and had 100 percent of the free world uranium enrichment market. By 1979, that had eroded to 69 percent, and we noted the intrusion of both the Soviets, which is TechsnabExport, shown there at 19 percent, and the initial production from Eurodif and URENCO.

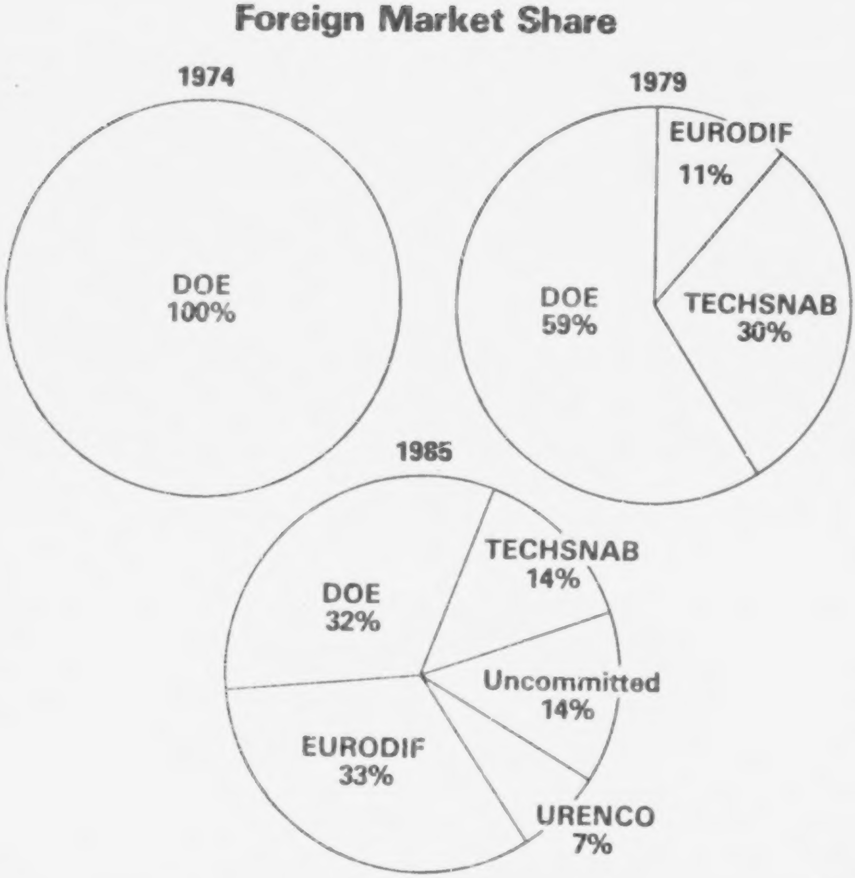
Mrs. LLOYD. For those in the audience, would you identify Eurodif and URENCO?

Mr. LONGENECKER. They are our two primary European competitors.

The results of the conversion to the U.S. contract is shown in the lower figure, which indicates that in 1985, DOE has 47 percent of the free world market share. Eurodif, in the period 1979 to 1985, had increased its market share, as you can see, from 10 to 22 percent. URENCO had doubled its market share to 5 percent. The Soviet market share had declined to 9 percent.

Two very visible segments of that chart indicate that a new phenomenon unforeseen in 1979 was the emergence of the large secondary market. We project that in 1985, 8 percent of the total free world needs will be met from the secondary market. At this time, there is an additional 9 percent of customer demand that is not committed to any supplier.

[Chart.]



Mr. LONGENECKER. Moving to our foreign market share, the situation is even more grave. Beginning with our monopoly position in 1974, we went to 59 percent of the foreign market in 1979, and in 1985 we estimate that we will serve 32 percent of the total free world needs for enrichment.

Eurodif's share of that market has tripled between 1979 and 1985 to 33 percent. URENCO has begun production and now meets 7 percent of the foreign market. There are currently, we estimate, 14 percent of the total foreign market share needs that are uncommitted to any supplier.

Now, one benefit of the U.S. contract has been that it has defined for us what our market share will be both now and during the next 10 years.

Mrs. LLOYD. What do you describe as uncommitted, those that have not signed long-term contracts?

Mr. LONGENECKER. That have a portion of their demand——

Mrs. LLOYD. They are buying on the secondary market?

Mr. LONGENECKER. They are either buying on the secondary market or they have not committed on a long-term contract to any supplier, which means that they could be using material out of their own inventories.

Mrs. LLOYD. Is that countries that have a partial contract but not a contract for the whole amount they are using?

Mr. LONGENECKER. Yes, and many of those, Madam Chairman, are using material that they currently have in their own inventory. So they are meeting a portion of their needs from the inventories that were previously built up through the take-or-pay contracts that they had either with us or with URENCO and Eurodif.

Mrs. LLOYD. One other thing, John. When you are comparing the market share for 1974 and 1984, what does 100 percent equate to? How many SWU's would 100 percent be, or how would you do that?

Mr. LONGENECKER. In 1985 the total free world demand is about 22 million SWU's.

Mrs. LLOYD. What was it in 1974?

Mr. LONGENECKER. Our sales in 1974 were on the order of about 10 million SWU's, as I recall. I will check that and give you a more precise figure for the record.

[Material to be supplied follows:]

In 1974 the AEC commercial deliveries were 13 million SWUs. This number includes about 6 million SWU of advanced sale deliveries to the Japanese.

Mrs. LLOYD. So, actually, the total market has more than doubled in the meantime?

Mr. LONGENECKER. It has approximately doubled in the last decade, yes.

Mrs. LLOYD. If we have 32 percent, and 14 percent uncommitted, if we could just up it a little bit, we would have the same capacity. We will need the same capacity for production as we needed in 1974. Is that not correct?

Mr. LONGENECKER. I am not sure I understand your question.

Mrs. LLOYD. Well, if the total SWU's in 1974 were 10 million, and we had 100 percent of the market, then you would need the same capacity in 1985 if we still had a market for 10 million SWU's, the capacity in the enrichment plants.

Mr. LONGENECKER. We are in a situation today of still being in a position of having excess capacity. We have 27 million SWU's of capacity on-line. It is a problem that is endemic to the free world uranium enrichment supply in that there are 40 million SWU's of installed capacity here, in Europe and in the Soviet Union, and total free world sales estimated in 1985 are about 22 million.

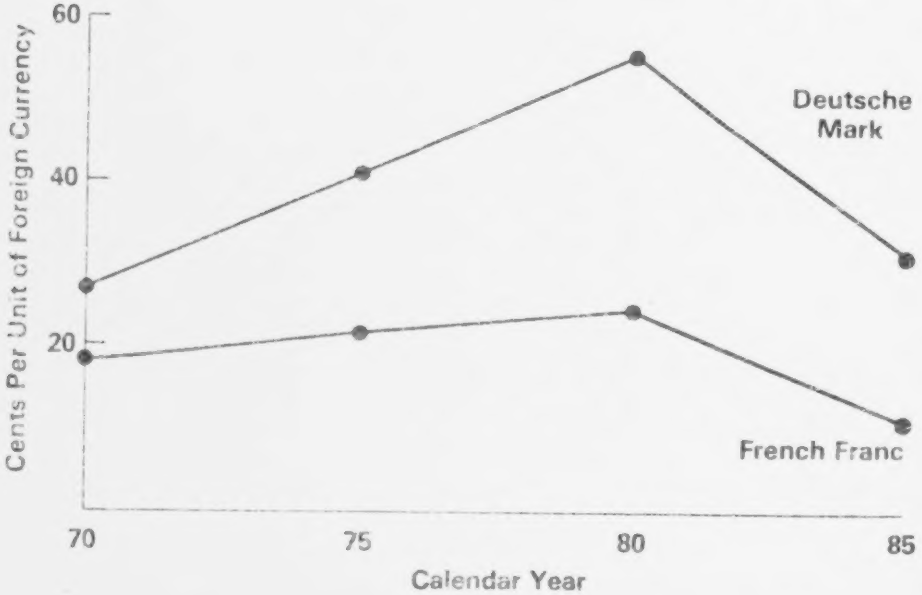
Mrs. LLOYD. So you have more than twice the world market capacity for the demand in SWU's at the present time?

Mr. LONGENECKER. Yes, Madam Chairman. We could meet the total free world need for enriched uranium in 1985 with our existing facilities.

Mrs. LLOYD. Thank you.

[Chart.]

Foreign Exchange Rates



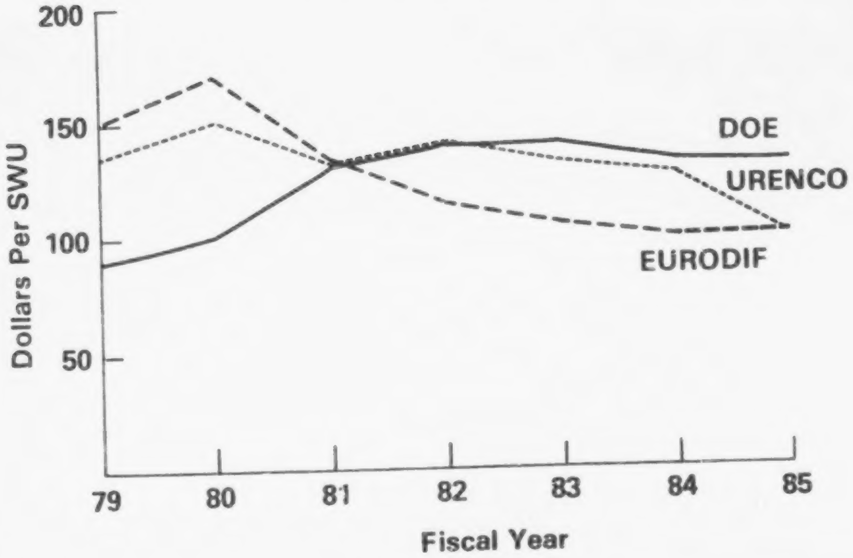
Mr. LONGENECKER. Another key factor that affects our market position, and quite drastically over the past 5 years, is the foreign exchange rate.

We discussed this factor with you last year, that the rate of exchange of our primary competitors had changed with the strengthening of the dollar to where we were put at an increasingly serious price disadvantage.

What has changed since last year is that the exchange rate disadvantage has worsened. If you recall, it was 8 French francs to the dollar 1 year ago; it was over 10 French francs to the dollar just last week. So the situation has worsened and may further erode in the future.

[Chart.]

SWU Price History By Supplier



Mr. LONGENECKER. That all translates into price. This is another chart that we showed you last year. We have updated it to 1985 to compare DOE's price with that of URENCO and Eurodif. You will note that although our price has declined slightly between 1984 and 1985, we are still the highest priced supplier in the world by some 20 to 40 percent.

[Chart.]

Utility Services Contract Conversion By Market Area

	Before Conversion		Conversion Results	
Market Share	Total Number of Customers	Share of DOE Market (%)	No. Converted	% of Total DOE Market
United States	52	59.6	45	55.8
Far East • Japan • South Korea • Taiwan	12	25.8	12	25.8
Europe • Spain • Netherlands • FRG • France • Sweden • Switzerland	18	12.4	11	6.8
Other • Philippines • Yugoslavia • Egypt • Mexico	4	2.2	4	2.2
TOTAL	86	100.0	72	90.6

Mr. Longenecker. Now, the specific results of converting customers to the U.S. contract was very positive for us. You will note in the far left column we have indicated our four primary markets. Before conversion, we had 86 customers—52 domestic and 34 foreign—under contract to DOE.

We lost 7 domestic customers and 7 foreign customers, all in the European market, and the result was that 72 of our 86 customers, representing almost 91 percent of our total sales base, converted to the U.S. contract.

Many of the European contracts that we lost, of course, would have expired or had been terminated in the late 1980's primarily because those countries are equity partners in either Eurodif or URENCO and had their own indigenous supply capability.

We feel, however, that the U.S. contract did correspond to the market, because we did get some member countries of Eurodif and URENCO converting to the contract; most notably Spain, some of the utilities in Germany, and two reactors of Electricitie de France.

Mrs. Lloyd. What sort of capacity does the Philippines have?

Mr. Longenecker. I am sorry?

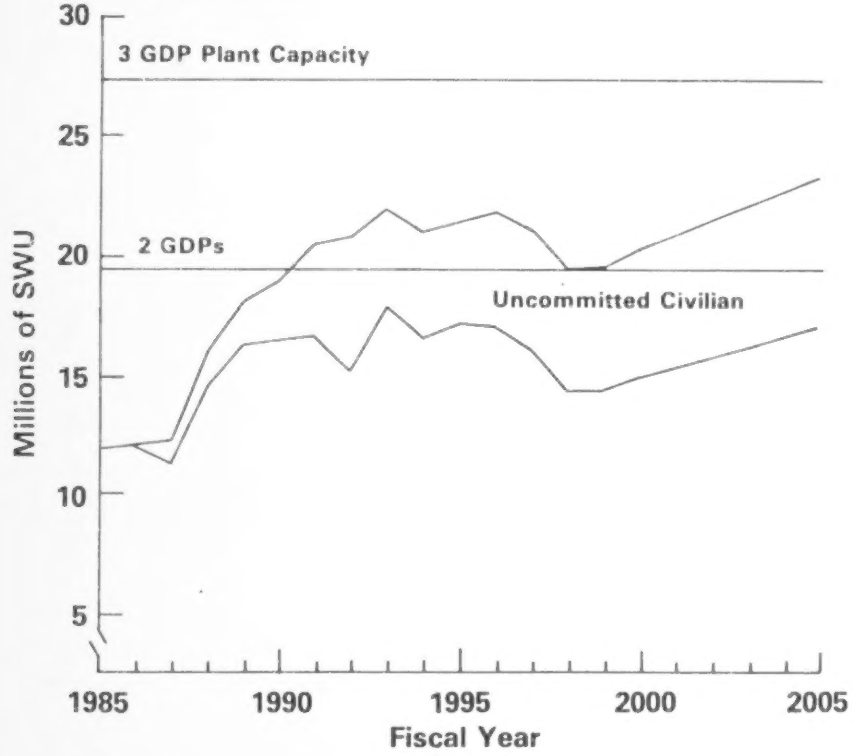
Mrs. Lloyd. How many nuclear plants do they have in the Philippines?

Mr. LONGENECKER. They are building two. They presently have one reactor which they plan to begin operating later this year, with plans to build another in the 1990's.

Mrs. LLOYD. And whom do they buy theirs from?

Mr. LONGENECKER. They are our customer, and they have converted that contract to the U.S. contract. The first reactor is currently covered by a U.S. contract and the second is uncommitted to any enrichment supplier.

[Chart.]



Potential Demand on DOE Enrichment Complex

- **0.25% U-235 Tails Assay**

Mr. LONGENECKER. Now, we have reduced that into the potential demand that the DOE enrichment complex must meet in the future. You will note that the bottom line is the compilation of all of the results of the U.S. contract conversion plus the military requirements that we must meet in support of U.S. defense programs.

The top line is the total of the civilian demand of all of our customers were they to buy 100 percent of their needs from us.

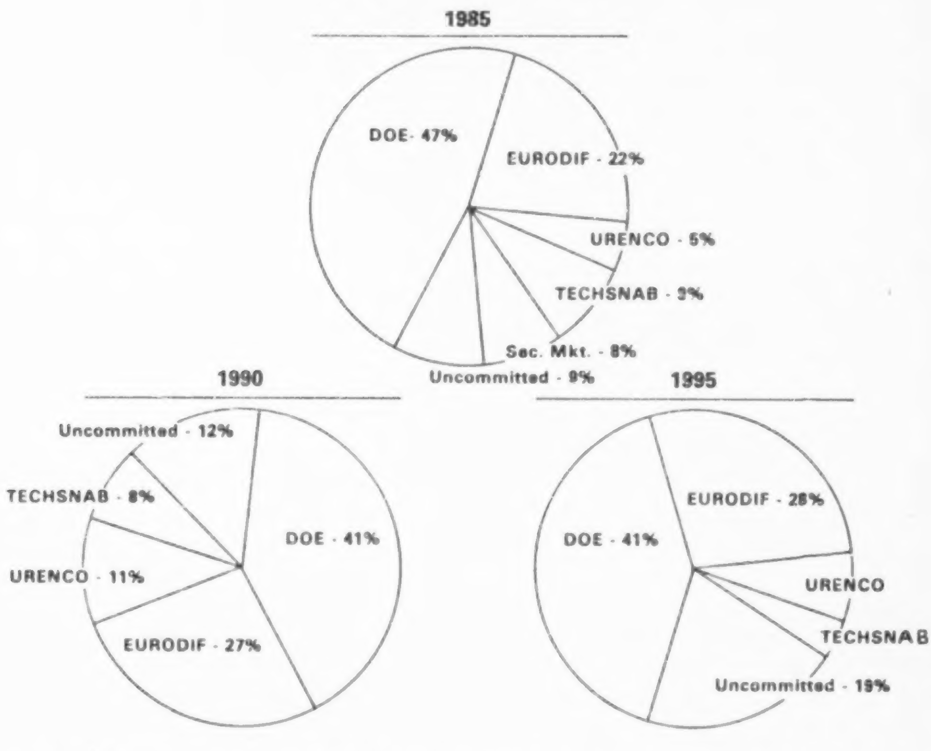
The area between those two lines that we have labeled "uncommitted civilian" is the market share for which we wish to compete. That competition will be based primarily on price—it is clear to us—and it really amplifies the importance of us getting our price down in the future.

Did you have a question on that, Mrs. Lloyd?

Mrs. LLOYD. No.

[Chart.]

World Market Share

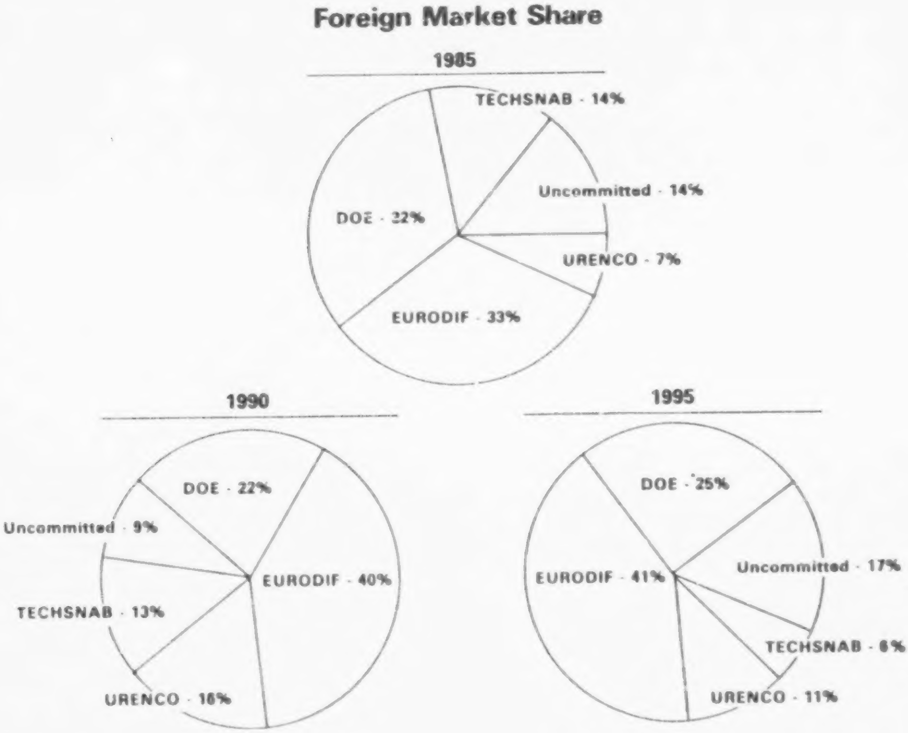


Mr. LONGENECKER. Looking forward, then, by market segment, breaking down that demand and projecting it 10 years in the future, from our 47 percent market share today, we estimate that by 1990 our market share may have eroded, our firm market share, by another 6 percent to where, both in 1990 and, we project, in 1995, we will be meeting 41 percent of the total free world requirements for enriched uranium.

Now, I would note that in both 1990 and in 1995, we show a large uncommitted market share from our customers. In 1990 we estimate that 12 percent of the total free world requirements are currently uncommitted on long-term contract to any supplier, and by 1995, there are 19 percent of the total free world requirements that are uncommitted. We estimate that by 1995, about 25 million to 27 million SWU's will be the total free world consumption.

But that uncommitted market share is what we and Eurodif and URENCO and the Soviets will be competing for. Again, today we believe that competition will be primarily on price, and again, this underscores the importance of our getting our price down in the future.

[Chart.]



Mr. LONGENECKER. Looking only at our foreign market share now, again between 1985 and 1995, we project in the next 5 years an erosion of 10 percent in our foreign market share, from 32 to 22 percent. We see in 1990, however, 9 percent of the total foreign market that is uncommitted to any suppiier, and in 1995, about 17 percent.

Now, between 1990 and 1995, our market share increases slightly, and that phenomenon is due primarily to new foreign orders, new reactors that will come online that are currently under contract to us.

Mrs. LLOYD. John, why do you have Eurodif's market projected at that growth rate? Is it because of the contracts they now have?

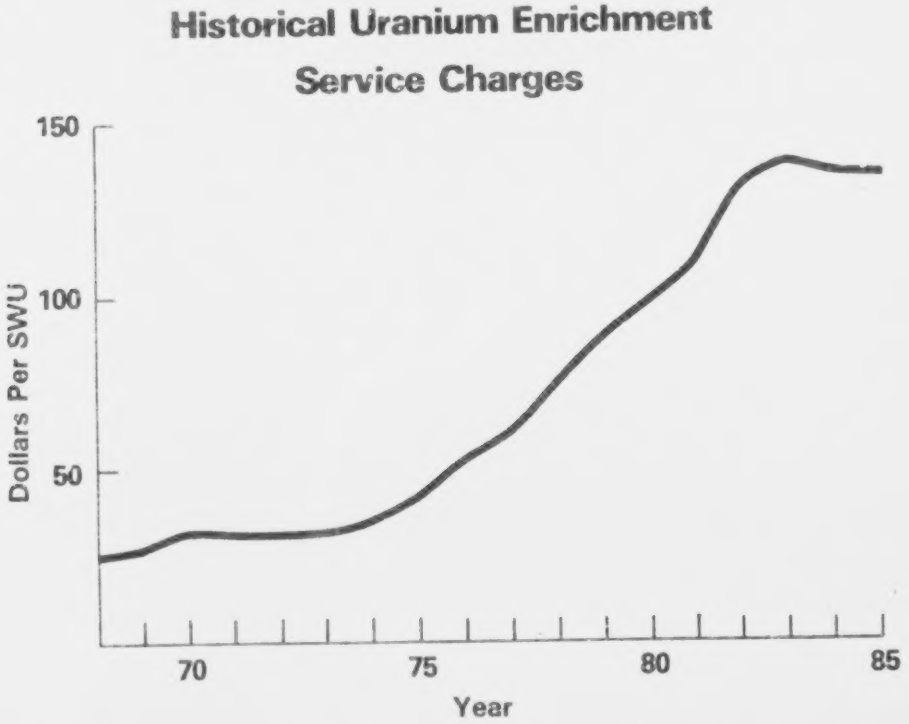
Mr. LONGENECKER. Eurodif is projected at that rate based on the contracts that they have in hand.

Mrs. LLOYD. Is that a better price or just our policy, or what accounts for that?

Mr. LONGENECKER. Their price is about 30 to 40 percent lower than ours today. Also, many of the larger nuclear countries in Europe, of course, are equity partners in either Eurodif or URENCO. As you know, France now generates over 50 percent of its electricity from nuclear plants and has a very vigorous nuclear program plan for the future. Their own nuclear program provides a substantial base load for Eurodif.

Mrs. LLOYD. Thank you.

[Chart.]



Mr. LONGENECKER. Again, looking backward to our price, you can see why we have lost that much of the market. This is the curve since we began civilian enriching in 1969. I have mentioned that we must compete in this very fierce international competition both on price and terms. The market is becoming increasingly price elastic.

This is how much we have charged for enrichment services through the last 15 years. You will note that since 1969–84, the price increased by a factor of 5. So the future key is to reverse the slope of the curve. We began that in 1984 with a slight decline in our price.

We are economizing on present-day operational costs in every aspect of the program, and we are particularly pleased with the cost reductions that have been achieved in the gaseous diffusion plants, most notably with the offpeak power and the experimental test energy that we spoke about earlier. The generation cost on offpeak at all three plants now is less than $40 per SWU, and in fact the weekend of February 27 at Oak Ridge, Paducah, and Portsmouth, we generated separative work offpeak at a marginal rate of $35 to $37.

Mrs. LLOYD. John, what does that look like in real dollars? Wouldn't that be about flat in real dollars, though?

Mr. LONGENECKER. That is a factor of 5 increase in 15 years, and in real dollars, no, that is still a rather healthy increase in our price. We were pricing in 1969 at $30 per SWU.

Mrs. LLOYD. What is your price on the new contract?

Mr. LONGENECKER. $135 in fiscal year 1985. That compares to a price of $138 for a fixed commitment contract in 1984 and $149 for a requirements contract. So it has come down slightly between 1984 and 1985.

Mrs. LLOYD. How long a contract term is that for the $135?

Mr. LONGENECKER. It is a maximum 30-year contract, with the ability to terminate free in 10 years.

Mrs. LLOYD. Thank you.

Mr. VAUGHAN. But, Madam Chairman, that price is a ceiling price, not a fixed price, and so one of our objectives is to further reduce our costs and to further reduce our price below that $135 per SWU level.

Mrs. LLOYD. If you don't mind, could we go back to figure 6?

Mr. LONGENECKER. Certainly.

Mr. VAUGHAN. Let's see what figure 6 is. That is the potential demand curve.

Mrs. LLOYD. Now, if you captured the uncommitted enrichment market, you would need about 2½ diffusion plants through the 1990's, would you not?

Mr. LONGENECKER. If we realized the total military demand and were able to obtain 100 percent of the customer demand that is currently under contract to us, we would exceed the capacity of two GDP's in about 1990. The maximum that that would reach is slightly less than 2½ GDP's, but it is in that range. It is about 22.5 million SWU's. Two GDP's is 19.5 million SWU's.

Mrs. LLOYD. That is correct, then; you need about 2½ diffusion plants through 1990.

Mr. LONGENECKER. If we were to secure the uncommitted civilian demand——

Mrs. LLOYD. Through the 1990's.

Mr. LONGENECKER. Yes, that demand right now is not under contract to us, so our planning base, in the absence of a way to obtain that market, would be the lower curve.

Mrs. LLOYD. Thank you.

Mr. VAUGHAN. Madam Chairman, I think it is also important that within the lower curve are some military requirements which will depend on what happens in the weapons program and the commitments in the future, and we cannot discuss those details in open hearings. But there are some military requirements under the lower curve.

Mrs. LLOYD. I would like to have that classified briefing if I could.

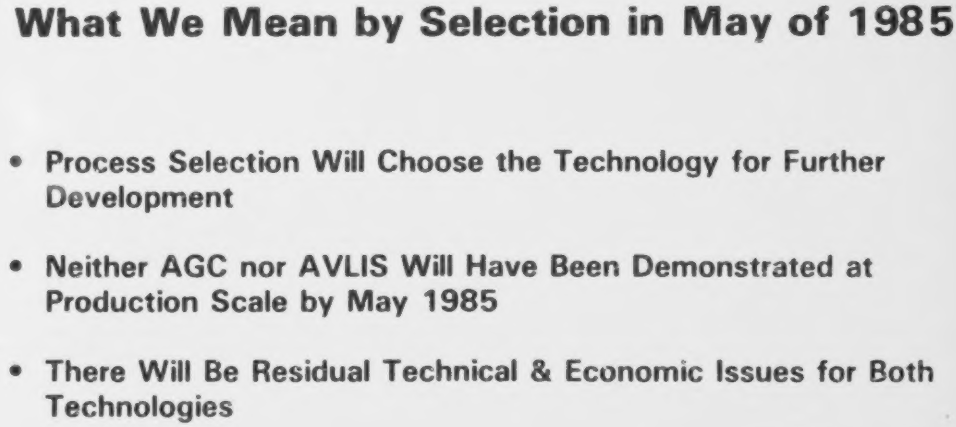
Thank you. Please go ahead.

Mr. LONGENECKER. Thank you.

I mentioned the progress we have made in the operation of existing gaseous diffusion plants, in getting our operating costs down and thus giving ourselves the potential for lowering the price over the next 5 to 10 years. The long-term key to price competitiveness, of course, is the advanced technologies, either the advanced gas centrifuge or the laser technology.

I would like to move now to a discussion of where we stand in the technology selection.

[Chart.]



What We Mean by Selection in May of 1985

- **Process Selection Will Choose the Technology for Further Development**
- **Neither AGC nor AVLIS Will Have Been Demonstrated at Production Scale by May 1985**
- **There Will Be Residual Technical & Economic Issues for Both Technologies**

Mr. LONGENCKER. The key to this effort, of course, is to select the best of the two technologies, to demonstrate it effectively, and then to deploy it at the appropriate time so that our price continues to decline and stay competitive.

It is important to focus on what we mean by selection in May 1985. The process selection will choose one of the two technologies for further development and potential deployment.

Mrs. LLOYD. So what you mean is that it will be the technology that you think looks the most promising.

Mr. LONGENECKER. That is correct.

Mrs. LLOYD. But it does not mean at that time that, hey, we are going to go with this one, and that is a definite commitment.

Mr. LONGENECKER. It is not a commitment to deploy either new technology. The primary reason is shown on the chart. It says, "Neither AGC nor AVLIS will have been demonstrated at production scale by May 1985." That was a deliberate strategy on our part, because the alternative to that was to demonstrate both at full-scale. That would have taken through the year 1987 or 1988 and would have required several hundred millions of dollars more in revenues to fund those two programs.

We believe that the technology selection activity has been thorough enough to date, both in the technical aspects of the technology and the economics, that we will be able to make an informed decision in May of this year, recognizing that there will be residual technical and economic issues for both technologies.

The next logical step then would be to proceed with reliability and operability testing of the winner, and we believe that by 1987 or 1988, we would be in a position to make an investment decision to deploy either of the technologies.

Now, a key factor in that, however, is the demonstrated ability of either technology to be deployed, to meet its technical targets, to meet its cost targets, and for us to have a way to finance it such that we do not increase our price by committing to a large new capital investment.

[Chart.]

Tasks of the PEB

- Assess Status of Science & Technology of AGC & AVLIS Uranium Enrichment Processes
- Evaluate Cost & Economics of Uranium Enrichment for the Two Processes
- Assess Impact & Risks to Uranium Enrichment Enterprise of Different Production Deployment Scenarios

Mr. LONGENECKER. I mentioned that this process is conducted by a process evaluation board. Their primary task, of course, is to evaluate the advanced technologies from both a scientific and an economic point of view.

The DOE members on this panel have met a number of times and heard both the scientific economic, cost, and schedule presentations from both technology advocates, and they are currently in the process of assessing the impacts and risks to the total uranium enrichment enterprise of deploying either an AVLIS or a centrifuge plant into the existing complex.

Their activity is currently on schedule, and they do plan to deliver their findings to the Secretary of Energy for his decision this May.

[Chart.]

How Process Evaluation Works

- **DOE Has Defined the Technical & Economic Data to Be Provided**
- **The PEB Has Defined the Initial Evaluation Criteria & Methodology, to Be Expanded if Needed as the Issues Are Better Defined**
- **The PEB Is Assisted by a "Peer Review" Process in Which Each Proponent Is Critiqued by the Other in the Presence of the PEB & in Writing**
- **Martin Marietta & Mitre Provide Support to the PEB on Economic Studies & Special Analyses on Issues Raised During Peer Review**

Mr. LONGENECKER. I will move to the next chart to describe how the PEB process works. Early on, the Process Evaluation Board defined both the technical and economic data that each of the technology advocates would have to provide to demonstrate their case.

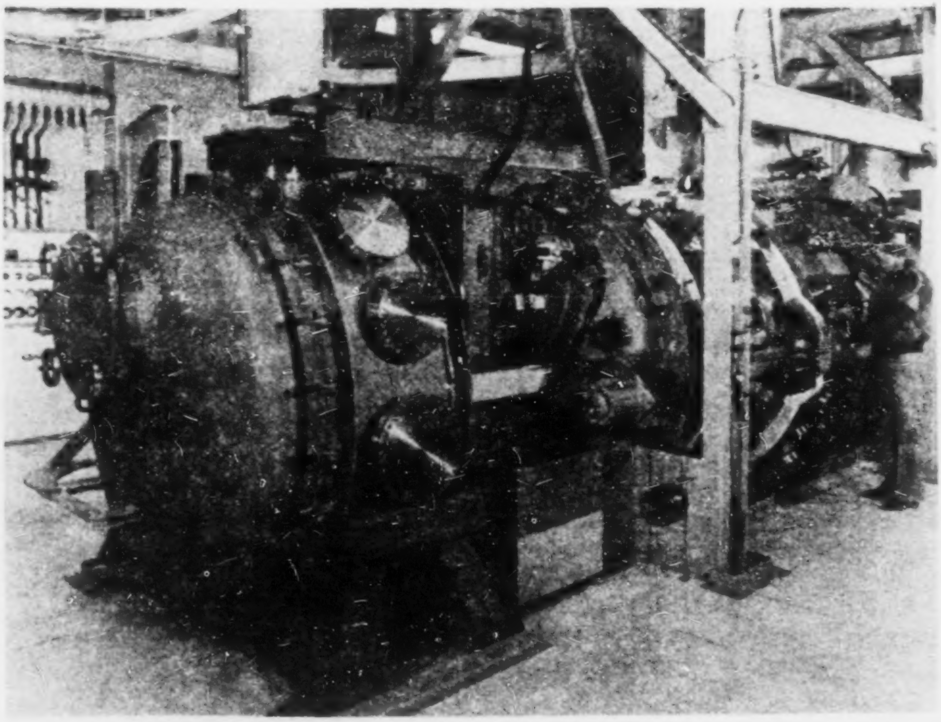
The PEB last June defined the initial evaluation criteria and methodology, and it has been defined, or better defined and refined, in a few areas as the evaluation has proceeded.

The PEB is assisted in this peer review process by having each of the technology advocates critique both the technical and economic representations of the other team. We are also assisted by the Mitre Corp. and by Martin Marietta in doing some independent technical and economic evaluation.

So it is a very thorough evaluation that we are undertaking. It is, as recommended by the Tricommittee Advisory Group on Uranium Enrichment, as much a business decision as a technical decision, and in the end analysis, any decision to deploy focuses most heavily on the total economic impact to the entire uranium enrichment enterprise.

I would like to provide a brief update on the two technologies if I may now.

[Chart.]



Mr. LONGENECKER. This is a photograph of the MARS facility at Lawrence Livermore where, this month, the AVLIS advocates plan to begin a one-half-scale demonstration of the AVLIS technology. Those data will be submitted to the Process Evaluation Board and considered by them in their final analysis and their findings to the Secretary.

Mrs. LLOYD. John, what type of demonstration of AVLIS do you think would be required for a deployment decision if AVLIS is the selected technology?

Mr. LONGENECKER. I believe that, without getting into the specifics of the program and the total funding required, I believe that a nearly full-scale demonstration of the technology, with prototypic run times for both the lasers and the separator, would be required before an investment decision could be made.

The lifetimes of the components in a laser system are relatively short by normal technological standards. The laser lifetime is 5,000 hours projected now. The separator runtime is 400 hours.

The key to demonstrating the economics of the laser process, once having gotten over the hurdle that it actually does perform and separate uranium with the efficiencies that the advocates claim, is to run in a prototypic way and get a handle on what the operating costs of the laser process at near full-scale are.

The AVLIS process has a characteristic that nearly 50 percent of the total cost of the process is for its operation. So that would require, prior to an investment, some demonstration at full scale for long enough——

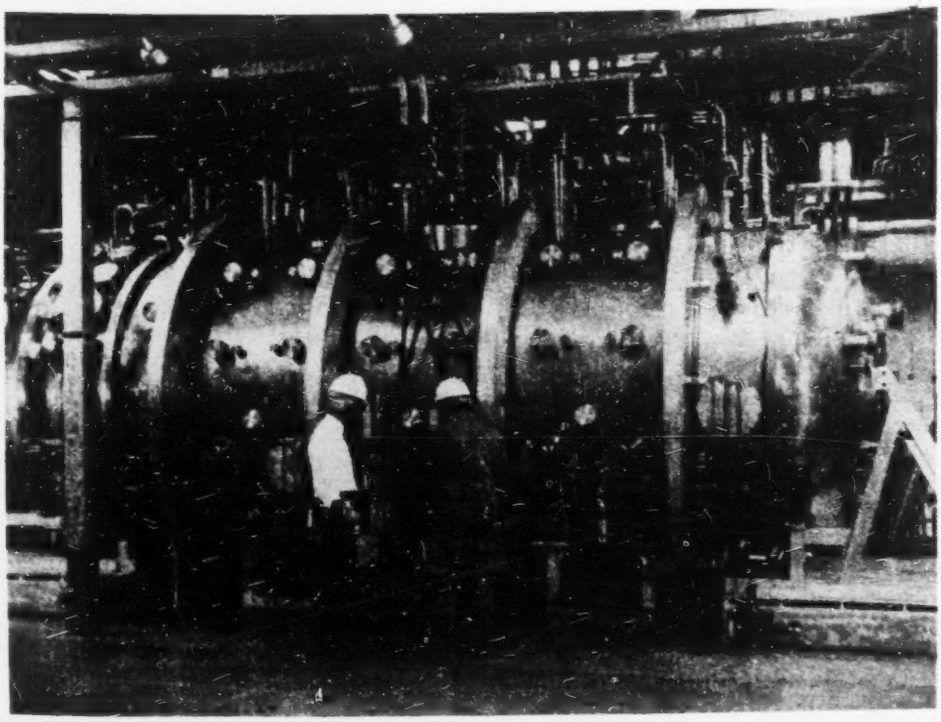
Mrs. LLOYD. Well, wouldn't it make more sense to do this at the site where you are going to actually build the facility—and this would be a modular site—instead of doing it twice?

Mr. LONGENECKER. The decision on where that demonstration would be done has not been made.

Mrs. LLOYD. I know, but wouldn't it make more sense to make that decision and do the modular there instead of doing this twice?

Mr. LONGENECKER. There are benefits to that that we are going to have weigh against the sunk investment that we have at other facilities. As you know, we do have a large separator facility, the MHDM—and I believe I have a chart of that—at Oak Ridge.

[Chart.]



That is MHDM at Oak Ridge. We have a rather sizable investment in that facility, and obviously, it would be a consideration as to where we would locate a demonstration.

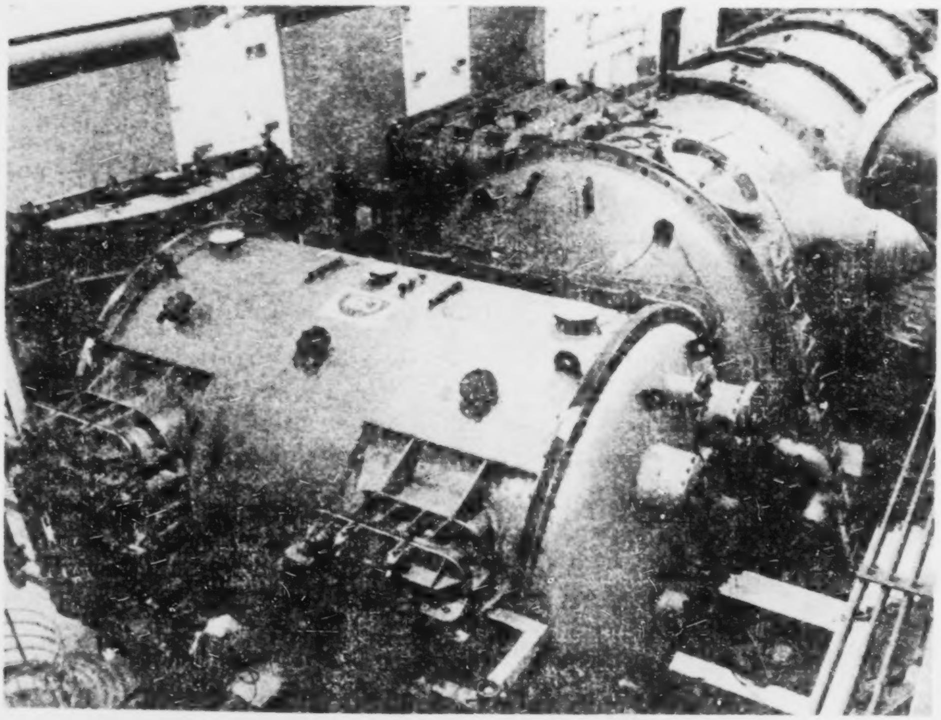
Mrs. LLOYD. You are answering the question the wrong way, John. Wouldn't it make more sense to do it at Oak Ridge instead of Livermore? [Laughter.]

Mr. LONGENECKER. I was going to show you the facilities we have at Livermore and tell you that we have got to make a decision between those two, or potentially one of the other gaseous diffusion plants.

Mrs. LLOYD. I think you missed the point. [Laughter.]

Mr. LONGENECKER. I believe I understand your point. [Laughter.]

[Chart.]



Mr. **Longenecker**. We do have a similar facility at Livermore, and we have capital sunk in both. That needs to be traded off against the potential for locating it on another site, and it will be done both on the technical benefit and the overall economic benefit of the program.

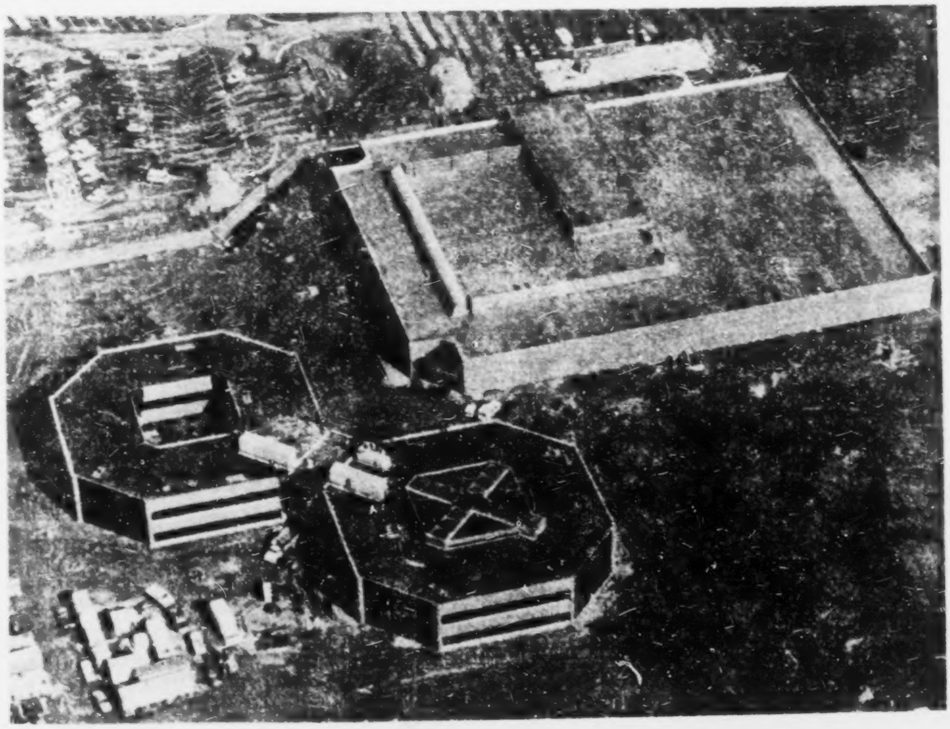
Mrs. **Lloyd**. I hope you will give that very serious consideration.

Mr. **Longenecker**. I will, Madam Chairman.

The MHDM, if I could say a few words about that, it has a key role in the AVLIS program. One of the key demonstrations that the PEB will want to have prior to its May recommendation to the Secretary is some prototypic data on the operation of the separator, and that is a nearly full-scale separator in MHDM. They began last week a run for MHDM and hope to achieve a 100-hour milestone prior to the end of March.

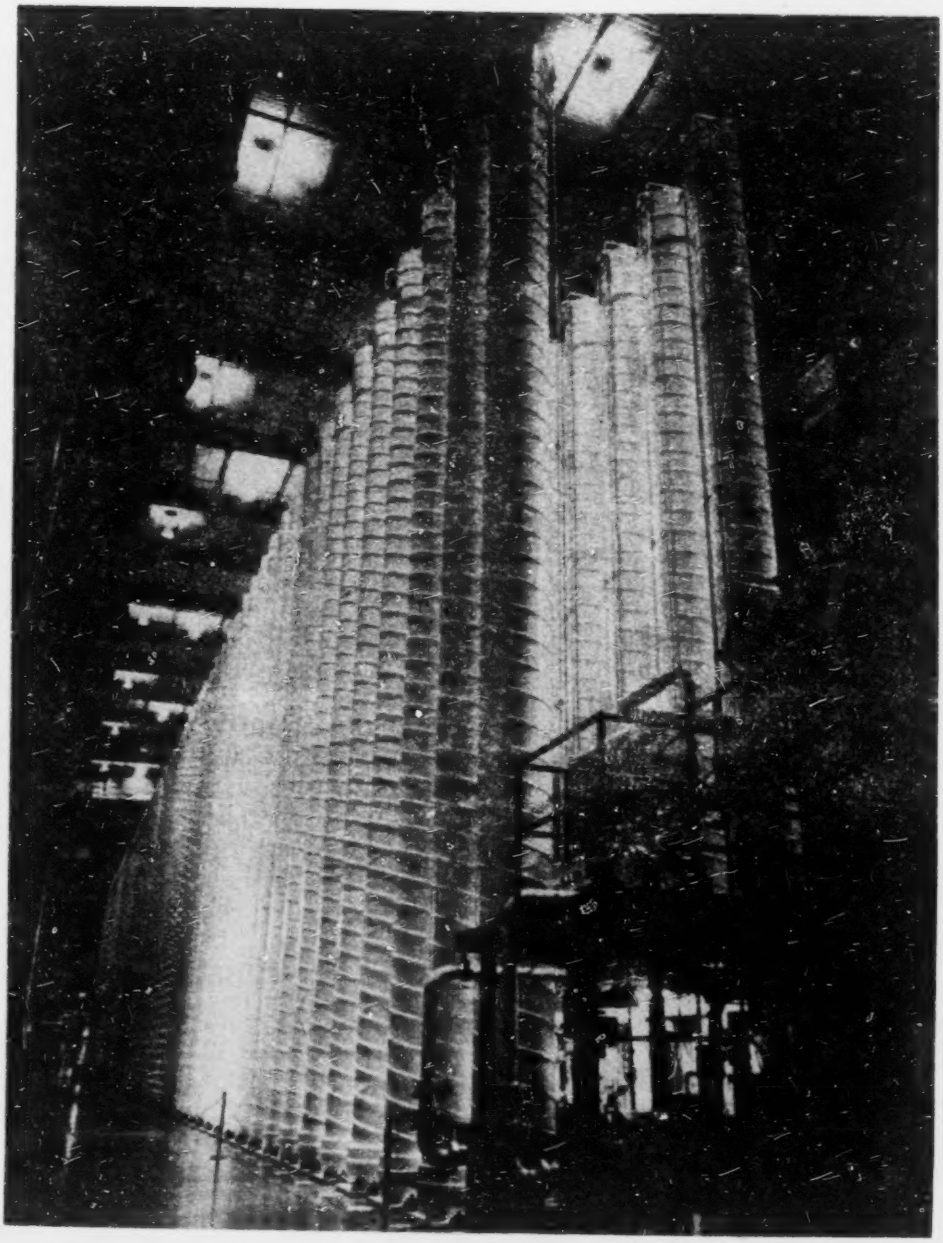
Similarly, in the facility I showed you at Livermore, they are beginning to run the bank of lasers that will power the MARS facility and hope to have it fully operational and demonstrate prior to the May decision the 1,000-hour laser life for that facility, the laser demonstration facility.

[Chart.]



Mr. LONGENECKER. Now, moving to the AGC program, a significant amount of progress has been made there in the last year. We will, by the May decision, have tested 11 full-size rotors and 12 minifuges, up to full speed in some of those.

The high-speed scoops for the set V machine will be characterized, and the improved suspension will have been tested by Air Research by a period exceeding 4 months.



What is shown here is a bay in the GCEP project. This is the site, in process building one, where, if the AGC technology is selected in May 1985, we would install the first 30 set V machines and conduct a reliability test.

So we have had good progress in both technologies. There is certainly not a clear winner in either right now. Both have made their representations on cost and technical performance, and they are being peer-reviewed by the other technology advocates and by the PEB, and the decision certainly will be open until they report their findings to the Secretary in May.

In the way of summary, I would say the future of uranium enrichment, one year after discussing the initial modification in our business strategy with you, is very bright. That has to do with some very hard work by the people at the gaseous diffusion plants, and the people at both DOE, Martin Marietta, and Goodyear have done outstanding work in the last year in making those plants more competitive.

The advanced gas centrifuge and the AVLIS advocates have done an outstanding job and have technically and administratively achieved milestones in the program that I am not sure any of us would have believed that they could have achieved 1 year ago.

It is not a painless process, however. We are fitting the program to the market. We are becoming more competitive on price and terms, and I believe we have made substantial strides in our marketing and sales capability.

It is a very difficult adjustment for a program of this size to make, however, and 1985 will be a period of very difficult decisions. There will be winning technology and a losing technology. We will need to make decisions regarding whether and when we shut down one of the gaseous diffusion plants, and we will need to make a recommendation to you on the future of the GCEP project.

Mrs. LLOYD. But no decision has been made on the gaseous diffusion plants at this time?

Mr. LONGENECKER. No, it has not, Madam Chairman.

I would like to add to what Mr. Vaughan said, in conclusion, in thanking the committee for its support in the past, and we ask for your continued support of our activities in the future. We have a very tough year ahead of us.

Thank you.

Mrs. LLOYD. Thank you very much.

Mr. Vaughan, we will excuse you now.

Mr. VAUGHAN. Thank you very much, Madam Chairman, for your courtesy in excusing me.

Mrs. LLOYD. You know, I have asked quite a few questions during the process of your presentation, so since I have, I think it is only proper that I now recognize the ranking minority member of our committee, Mr. Morrison, and also for any opening statements that you would like to make.

Mr. MORRISON. Thank you, Madam Chairman.

I was out jousting with my county commissioners and a few minutes late. I would ask unanimous consent that my opening statement be allowed to be part of the record.

Mrs. LLOYD. Without objection, it will appear at this point in the record.

Mr. MORRISON. Thank you.

[The opening statement of Mr. Morrison follows:]

OPENING STATEMENT OF HON. SID MORRISON ON THE FISCAL YEAR 1986 DOE AUTHORIZATION REQUEST FOR URANIUM ENRICHMENT ACTIVITIES

Good morning. Today we complete our review of the Department of Energy budget authorization for the uranium enrichment activities. Last week we set the stage by hearing from a variety of nongovernment witnesses; now I'm anxious to hear DOE's side of the story. To do this, we are joined this morning by Jim Vaughan, back for his third return engagement, and John Longenecker, the Deputy Assistant Secretary for Uranium Enrichment.

As I indicated at last week's hearing, I will approach uranium enrichment from a fresh viewpoint which will focus on achieving two essential objectives: selecting the best technology and improving our revenue situation. Based upon last week's testimony, I'd say we are well on our way to reaching these twin goals.

The technology choice between the Advanced Gas Centrifuge and AVLIS will be a difficult one. But in the interest of the taxpayers, the decision must be made in a timely basis, and I urge DOE to base their decision on selecting the most reliable technology at the best price.

The operation of our current gaseous diffusion program must also be sensitive to the concerns of the taxpayers. We heard substantial praise last week of DOE's new business-like approach to enrichment services. DOE's more market-driven program—particularly the new Utility Service Contract—should pay dividends. I'm hopeful that with this business-like emphasis we can avoid revenue shortfalls and attain our once dominant position in the world enrichment services market.

Thank you Madam Chairman.

Mr. MORRISON. I sort of come into this subject, as my statement indicates, as it did last week, as a beginner. Perhaps, if we have a few moments, my beginning line of questioning could revolve around how we got where we are.

Let me sort of paraphrase if I could, Mr. Longenecker, and then you correct me. Of course, we have counted through the years on the gaseous diffusion process as the basis, and that gave us really world dominance in this entire area as recently as a decade ago.

Then is it fair to assume that the centrifuge process came along as the most promising new technology, and we made a significant investment in that, going back to about 1977 or thereabouts?

Mr. LONGENECKER. That is correct.

Mr. MORRISON. And then that the AVLIS process came along as the new kid on the block and had a great deal of promise, and it has been in competition with centrifuge since then to the point that it leads us to May 1985 as D-day for the Department?

Mr. LONGENECKER. That is correct.

Mr. MORRISON. I am sort of interested in the D-day. Is the May date firm? Everything you say seems to point to it, but is that—and I see a number of pieces coming together, your Evaluation Board and other things, all aimed toward May. But is that May date firm?

Mr. LONGENECKER. Yes, sir, it is.

We obviously will not make a recommendation to the Secretary and recommend that he make a decision if there is a key piece of data that is absent in that timeframe, but as the program has been constructed and as it has unfolded over the last year, we believe that all of the key data will be in place to allow a May decision.

Mr. MORRISON. Then as I understand your comments on the timetable as it continues, between May 1985, when you reach a decision, and further demonstrations, that by 1988 we will make a decision as to which enrichment program or technology we actually utilize as a Nation in continuing the enrichment programs.

Mr. LONGENECKER. We believe that we will be in a position in that timeframe to make a decision on whether to deploy the winning technology.

Mr. MORRISON. Through actual demonstration?

Mr. LONGENECKER. Yes.

Mr. MORRISON. Thank you. That helps my understanding.

What happens to the $150 million that is slated for R&D if you choose one technology—in fact, give me the scenario for both technologies when you make that decision in May. What is going to happen to that $150 million R&D?

Mr. LONGENECKER. The most recent deployment scenarios that have been proposed by the technology advocates requested about $100 million for the advanced gas centrifuge technology in the case that it wins, and about $125 million for AVLIS, were it to win.

The remainder of those funds would be applied, roughly speaking, to the loser, provided that there is a demonstrated need for the losing technology to be supported at that level. So, roughly, we would allocate them $125 million for the winner, $25 to $50 million for the loser. We will be providing specific detail to the Congress on that with our decision package in May.

Mr. MORRISON. If you select the AVLIS technology, how can we get the most out of the investment we have made in the gas centrifuge plant?

Mr. LONGENECKER. We are looking at a number of options, Mr. Morrison, including zero, one-half, two, and four building cases, with varying missions and various combinations of set III and set V machines.

We have not reached a conclusion on the optimum means in which one could operate GCEP in the case of an AGC loss, but that will be a part of our recommendation to the Congress in May.

Mr. MORRISON. I am interested—and I don't know—what are our competitors, who seem to be picking up an ever-increasing part of the market, utilizing as far as technology?

Mr. LONGENECKER. They are using two different technologies. Eurodif uses gaseous diffusion, and URENCO uses centrifuge technology.

They are competitive today for a number of factors unrelated to technology. If you notice those charts that I used in my overview and your question as to what has changed from 1969 to today, or what has changed in the last 5 years that has brought us to this point, the cost of electricity is one key factor. Gaseous diffusion is a very energy-intensive technology. Almost 80 percent of the cost of gaseous diffusion is electricity.

We made a commitment to the centrifuge program in a period when electricity prices were escalating at between 10 and 15 percent per year and projecting those out for 10 years, it showed a much different picture for gaseous diffusion plant economics than we see today, when over the past few years we have seen no or slightly a negative real growth in electricity rates.

The rate of foreign exchange has certainly impacted that. When both Eurodif and URENCO brought their plants up in the late 1970's, early 1980's, if you recall that one chart that I showed, they were approximately 40 to 50 percent higher in price than we were. The dollar has doubled in its strength as compared to the Deutsche mark and the French franc, which are the competitors' currency, and that has helped them a great deal.

Finally, we made a large commitment in the mid-1970's to research and development on two technologies and to construction of what was anticipated to be an $8 billion project at GCEP, and at that point in time, we had the projected revenues and the market position to be able to do that.

So when the other factors that I mentioned, the cost of power and the rate of currency exchange, went in our competitors' favor, we found ourselves spending over half a billion dollars per year and approaching three-quarters of a billion dollars per year for new plant construction and research and development, and we were expensing that, adding it to our price structure every year, and that by the nature of it made us not price competitive and gave us very limited flexibility to shed costs quickly and get our price down to the competitive range.

Mr. MORRISON. Are your competitors subsidizing their price?

Mr. LONGENECKER. We think they are. They are still offering deep discounts in this country from our prices, and we believe that the foreign governments who are participants in those programs continue to subsidize them.

Mr. MORRISON. Are you basing some of your assumptions on world market, as you project on into the future, on their learning their lesson once we become efficient again, and that market shares will be based on the actual cost of production all around the world?

Mr. LONGENECKER. In our projections that I showed going through 1995, we have assumed in the base curve that we retain only 70 percent of the customer requirements that are committed to us under the U.S. contract. We believe that the other percent is price-elastic, and we can compete for it, but until we can see our price coming closer to those of our competitors, we don't believe that it is reasonable for us to assume that we will get those sales.

Mr. MORRISON. One other question. I guess this comes to me from out of the Northwest, where we are rather sensitive to prices for electricity now. At what price per kilowatt-hour or dollars per megawatt-hour could we provide enrichment services and be competitive with our friends in Europe?

Mr. LONGENECKER. That is a difficult question. Let me answer it two ways. I will tell you what the straightforward production costs are from gaseous diffusion plants, but then we must factor that into our total pricing equation, which also charges some element for research and development and an element for new plant construction.

Right now we are obtaining power from TVA for 34.7 mills per kilowatt-hour; from EEI, for our Paducah plant, at 23.8 mills per kilowatt-hour; and from OVEC for about 19 mills per kilowatt-hour. Now, at TVA we have the additional charge in 1985 of almost $350 million for demand charge that is not taken, power we have under contract but are not currently utilizing.

Mr. MORRISON. Excuse me, could I interrupt there? Don't they have some sort of an incentive rate potential because of surplus now in that region?

Mr. LONGENECKER. TVA is currently selling us offpeak power at prevailing rates, and we have bought it as low as 18 mills for the energy, but we still have to pay the demand charge, which amounts to about 10 mills per kilowatt-hour.

The production cost to reduce all of that data to a simple number in SWU price, at 18 mills per kilowatt-hour, you produce SWU's at a marginal cost of about $36 per SWU.

We estimate that in the future, once we have gotten out of the TVA demand charge and we have all firm power under contract for the GDP's, the steady-state operating cost in today's dollars of gaseous diffusion is on the order of $70 to $75 per SWU. So to that energy one must add operating costs, upkeep of the facilities, and maintenance.

In steady state, with power rates in the range of what we are paying firm rates at TVA right now, we would estimate that the steady-state operating cost would be in the order of $70 to $75 per SWU.

What that tells you is that the difference between what we produce at today and what we sell at is the difference in capital recovery for past Government investment, imputed interest, depreciation of existing facilities, and an annual expensing of the research and development and construction of any new facility.

So we could, if we did not have an R&D program or a construction program for new capacity, price much lower than we are pricing at today, but we believe that that would effectively foreclose our option for the future to compete.

Mr. Morrison. And I suppose it also effectively flies in the face of what Congress has been forcing on you, and that is to let this process make money somehow for the taxpayers' investment.

Mr. Longenecker. We try to operate like a business, and we found ourselves, 1 to 2 years ago, in a situation where the market had changed drastically and we had not adjusted our program.

A logical step for us to take in the environment we are in today is to try to get our price down through cutting costs for operation of the gaseous diffusion plants, but also taking a very realistic look at how much we spend each year on research and development and on how much we spend on new plant construction, without foreclosing the opportunity to compete with new technologies in the future.

We will incorporate in our May plan to you—and must consider on a continuing basis—what that new technology and new plant construction does to our price base, because it can add significant upward price pressure under the current accounting rules and thus make us less competitive.

So it is a very fine balance between retaining the advanced technology option for the future and deploying it at precisely the right time to assure that we remain price competitive.

Mr. Morrison. Thank you very much, Madam Chairman.

Obviously, we look forward to May and some rather interesting decisions. Thank you for your courtesy in the extra time you have allowed.

Mrs. Lloyd. Thank you very much, Mr. Morrison.

Would you explain to Mr. Morrison the reason there are demand charges with TVA? I don't think that was quite clarified.

Mr. Longenecker. Yes. In the early 1970's, when we were projecting very high nuclear power growth in the United States and abroad, and we in fact had at that time under contract to us in excess of 30 million of SWU's of capacity from our customers, we contracted with TVA for an amount of power sufficient to fully power up Paducah and the Oak Ridge gaseous diffusion plant.

Again, putting it in numbers that are simple to reduce to arithmetic, we have got 4,485 megawatts of power under contract right now, and we are using around 500 megawatts at Oak Ridge, so we are paying the demand charge to TVA because of the overprediction of the need for capacity for almost 4,000 megawatts of demand.

Mrs. **Lloyd.** A powerplant was built to accommodate.

Mr. **Morrison.** I might mention, Madam Chairman, that we had, for a variety of reasons, the same sort of optimism in the Northwest, and we are paying some demand charges to the Bonneville Power Administration in the same vein as the charges described here.

Thank you.

Mrs. **Lloyd.** Thank you.

John, what is your assessment of the need to shut down a uranium enrichment plant? Would you elaborate on the studies that you have taken on the need to proceed in this fashion?

Mr. **Longenecker.** We are evaluating the potential for closing or putting in standby one of the three gaseous diffusion plants, and that report will be an integral part of our production plan in May.

What we have done over the past year in assisting us in making that evaluation is, we have asked the GDP advocates to update their economic and technical data base for all three plants, present it both to us and to the Process Evaluation Board for consideration in the technology selection.

The reason for that is that the benchmark economics that the new technologies must exceed are the gaseous diffusion plant production costs.

We also began an analysis last year of the socioeconomic impacts at Oak Ridge, Paducah, and Portsmouth.

Mrs. **Lloyd.** What are the results of that?

Mr. **Longenecker.** The results of it are in draft form now. We issued the draft socioeconomic report February 15 for a second public review and comment, and we plan to hold public hearings tentatively the week of March 25 at all three sites.

What it shows, reducing it to its two simplest figures of merit, is that approximately 835 jobs would be lost at Oak Ridge if that plant were to close.

Mrs. **Lloyd.** How many?

Mr. **Longenecker.** Eight hundred and thirty-five. There would be 880 at Portsmouth, and 1,200 at Paducah.

The range of lost income is the other key figure of merit as compared to the total economic base of the region, and there it is estimated to be 1 percent at Portsmouth, ½ percent at Oak Ridge, and 2 percent at Paducah.

So that tells you that the most severe socioeconomic impacts would be at Paducah, which is not surprising, since it is a single-purpose facility.

Mrs. **Lloyd.** Well, of course, you know that I have a personal interest in the decision, and I also want to see that what is done is in the best interest of our Nation as well. But wouldn't the fact that Oak Ridge is the center for all of our administration and engineering support for the uranium enrichment enterprise be a significant and overriding factor in considering the shutdown? What elements have been studied in the analysis of this in terms of personnel transfers and moving expenses, and so forth?

Mr. LONGENECKER. It is anticipated that the principal impact of closing the gaseous diffusion plant at Oak Ridge would be on those employees that directly support the GDP; that is, the roughly 835 jobs that are cited in the socioeconomic draft report, as compared to—there are now about 4,000 people working at K-25, and those other people who support AGC and GCEP and AVLIS and other general support programs would not be impacted by a GDP shutdown.

Now, the factor has been considered by us, and that is one of the reasons why you see a larger job impact by closing Paducah than Oak Ridge, since the Oak Ridge gaseous diffusion plant provides administrative and technical support to both plants. We will consider that factor, Mrs. Lloyd.

Mrs. LLOYD. What were the numbers for K-25 again?

Mr. LONGENECKER. There are around 4,000 people. The number that I recall is 3,991 on last month's report, and I think, for rounding purposes, 4,000 is probably a good number to use here. And 835 of those are estimated to be laid off in the case of a shutdown of ORGDP.

Mrs. LLOYD. One DOE socioeconomic assessment is titled "Partial Closure of the Oak Ridge Uranium Enrichment Facility." Would you comment on what the partial closure means and how this could be accomplished?

Mr. LONGENECKER. We have looked at the option of closing one-half of Paducah. As you know, that plant configuration is such that there are two separate and distinct cascades. It is possible that you could close one of those—and that is slightly over 11 million SWU's total capacity—and still keep half of the plant operating.

The economics of that are not particularly attractive in our initial analysis because we could utilize approximately all but 100 of the people to operate half the plant. Put another way, it would require all but approximately 100 of the people to operate half of Paducah, and therefore, there is not a significant cost savings, except for the power required to operate that cascade if we were to shut down or put half of it into standby.

Mrs. LLOYD. I meant the Oak Ridge plant, partial closure of the Oak Ridge plant.

Mr. LONGENECKER. An option that we have studied at all three plants is standby or partial closure, if you will, of the plant for a limited period of time, say, 3 to 5 years.

That does make some sense. The manpower impacts are less, but it would have to be predicated upon needing that additional capacity to come back online at some point in the reasonably near future. But that is one of the options that we will evaluate.

Mrs. LLOYD. Is that what you mean by partial closure, though, of the Oak Ridge facility?

Mr. LONGENECKER. I was referring to——

Mrs. LLOYD. That is the title of a study that was made that I was referring to. Partial Closure of the Oak Ridge Uranium Enrichment Facility is the title of a DOE socioeconomic assessment.

Mr. LONGENECKER. I am sorry, I misunderstood your question.

The partial closure that they are referring to is—they looked at three options. One was closing the gaseous diffusion plant, viewing the uranium enrichment operation as K-25, the 4,000 people employed there.

There was another option where they looked at AGC losses and the centrifuge program is closed down. A third option looked at both the combination of the effect of closing the GDP and closeout of the Centrifuge Program.

But it is that specific portion of the Uranium Enrichment Program that could be impacted by the May decision that was evaluated from the socioeconomic study point of view.

Mrs. LLOYD. You know, many of the people who are working under the enrichment umbrella at Oak Ridge are providing other services, as you know—engineering, administrative—to the other two plants as well as to the facility at Oak Ridge.

Would a more accurate charging of the individual's time result in a lower cost being attributed to the Oak Ridge gaseous diffusion plant?

Mr. LONGENECKER. We believe that the costs as they are currently allocated are fair. We have looked at that during the last year as part of the GDP economic evaluation. We asked each of the three plants, both individually and then working as a group, to come and propose to us, from a cost center point of view, what costs were fairly chargeable to gaseous diffusion, and then what charges were fairly chargeable to each of the three plants.

Recognizing that Oak Ridge currently provides the administrative, financial, and accounting support to both Oak Ridge and Paducah, our estimate of the number of staff that would be terminated in a shutdown is nearly 400 higher for the Paducah shutdown because of the need to retain that staff at Oak Ridge.

But we believe that the allocation developed over the last year for each of the plants on a cost-center basis is fair and reasonable.

Mrs. LLOYD. You feel that you have equitably allocated the costs in terms of personnel and management?

Mr. LONGENECKER. I believe so.

Mrs. LLOYD. John, I will have further questions that I would like to submit in writing for you to answer for the record.

Did you have more questions, Sid?

Mr. MORRISON. No, thank you.

Mrs. LLOYD. We appreciate your being with us again this morning. You are certainly an excellent witness, and we enjoy working with you in this very trying and very moving experience.

The subcommittee will meet again Thursday, March 7, at 9 a.m., in room 2325, Rayburn, when we will hear from DOE and non-Government witnesses on the Electric Energy Systems, Energy Storage Systems, and the Small-Scale Hydroelectric Systems Program.

The subcommittee is now adjourned. Thank you for being with us, ladies and gentlemen.

[Whereupon, at 9:53 a.m., the subcommittee recessed, to reconvene at 9:40 a.m. on Thursday, March 7, 1985.]

1986 DEPARTMENT OF ENERGY AUTHORIZATION

THURSDAY, MARCH 7, 1985

House of Representatives,
Committee on Science and Technology,
Subcommittee on Energy Research and Production,
Washington, DC

The subcommittee met, pursuant to notice, at 9:40 a.m., in room 2325, Rayburn House Office Building, Hon. Tim Valentine (acting as chairman of the subcommittee) presiding.

Present: Representatives Valentine, Stallings, and Morrison.

Staff present: Nancy Jeffery and Tim Peckinpaugh.

Mr. Valentine. I don't think I need to use this gavel because I believe we have order. I apologize for being a little late to get here. I had breakfast with the President, I must mention that, we meet quite often for breakfast, especially around MX time.

Today we will continue our program hearings on fiscal year 1986, Department of Energy budget requests. This morning we will receive testimony from DOE and non-Government witnesses on the Electric Energy Systems, Energy Storage Systems, and Small-Scale Hydropower Programs. While these programs represent only a small portion of our annual authorization budget, they nevertheless comprise a necessary element in our energy research efforts. The history of these programs, Electric Energy Systems and Energy Storage Systems in particular, has been one of budget level gyrations. Once again this year we are faced with a proposed budget which will severely impact current research programs.

For example, the Electric Energy Systems Programs would be reduced to one-half of fiscal year 1985 appropriated budget level of $20.7 million. The major reductions would occur within the Systems Technology Subprogram, which provides the concepts, the materials, and test procedures to make future systems improvements possible. However, low budget levels will also impact important activities such as electric field effects research, which is related to—which is related to biological research on magnetic field effects.

The Energy Storage Systems Programs would be reduced by approximately one-fourth of the fiscal year 1985 appropriated level. The technology development in this program will ultimately support electric vehicle development, utility load leveling, and fuel displacement. Among the subprogram areas to be reduced in the electrochemical storage category would be research on electrochemical conversion systems and efforts on sodium-sulfur and zinc-bromine battery development.

Finally, our third area of consideration today is a Small-Scale Hydropower Program. The Department has requested a slight increase in funding for this activity. When this program was established in 1977 the goal was to develop a technology base which would reestablish a small hydropower industry in the United States. The program to date has been a success with an average of 780 preliminary permit applications for small-scale hydropower projects submitted annually to the FERC. The small increase would be used to facilitate technology transfer to the private sector.

I hope our witnesses today will enlighten us as to what adequate funding levels will be necessary to allow the Department of Energy to continue these important programs with even a modest level of activity.

[The opening statement of Mr. Valentine follows:]

OPENING REMARKS OF HON. TIM VALENTINE, FISCAL YEAR 1986 DOE AUTHORIZATION HEARING, ELECTRIC ENERGY SYSTEMS, ENERGY STORAGE SYSTEMS, AND SMALL-SCALE HYDROPOWER

The subcommittee will come to order. Good morning. Today we will continue our program hearings on the fiscal year 1986 Department of Energy budget request. This morning we will receive testimony from DOE and nongovernment witnesses on the Electric Energy Systems, Energy Storage Systems, and Small-Scale Hydropower Programs.

While these programs represent only a small portion of our annual authorization budget, they nevertheless comprise a necessary element in our energy research efforts. The history of these programs, Electric Energy Systems and Energy Storage Systems in particular, has been one of budget level gyrations. Once again this year we are faced with a proposed budget which will severely impact current research programs.

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I hope our witnesses today will enlighten us as to what adequate funding levels will be necessary to allow the Department of Energy to continue these important programs with even a modest level of activity.

Mr. VALENTINE. Now, before we hear from our first witness I'd like to recognize the ranking Republican member, Congressman Sid Morrison, for any opening statement or comments which he has to make.

Mr. MORRISON. Thank you, Mr. Chairman. As the chairman has indicated, our hearing today covers the budgets for the Electric Energy Systems, Energy Storage Programs and Hydropower Programs. Combined, these represent a relatively small share of the overall DOE energy supply research and development budget. However, the small budgets for these programs should not detract from their importance.

While overall energy consumption has been decreasing, electricity consumption continues to grow at a faster pace than Gross National Product. This underscores the need for us to focus our R&D efforts on electric power. Indeed, these electricity R&D systems are critical to our Nation's effort to more efficiently and safely use, transport, and store electric energy.

These research programs have absorbed substantial cuts in the proposed administration budget and we need to scrutinize this very closely. We need to discern which of these R&D programs are already or can easily be performed by the private utilities and their technical support organizations, such as the Electric Power Research Institute. We must limit the dwindling Federal R&D dollar only to those programs which cannot be funded by the private sector. If some of these Electric Energy Supply, Energy Storage and Hydropower Programs can be picked up by the utilities, we need to phaseout the Federal role. If this is not the case, some Federal support for these programs is justified. This is the fundamental inquiry that this subcommittee should make in this morning's hearing and thank you very much, Mr. Chairman.

[The opening statement of Mr. Morrison follows:]

OPENING STATEMENT OF HON. SID MORRISON ON THE FISCAL YEAR 1986 DOE AUTHORIZATION REQUEST FOR ELECTRIC ENERGY, SYSTEMS, ENERGY STORAGE, AND HYDOROPOWER PROGRAMS

Good morning. As the chairman has indicated, our hearing today covers the budgets for the Electric Energy Systems, Energy Storage Programs, and Hydropower Programs. These combined programs represent a relatively small share of the overall DOE Energy Supply Research and Development budget. However, the small budgets for these programs should not detract from their importance.

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Thank you, Madam Chairman.

Mr. VALENTINE. Thank you, Mr. Morrison. Our first witness is the Honorable Pat Collins, Under Secretary of the Department of Energy. We, of course, are glad to have you here and to take your testimony. You are free to proceed in any manner that you deem appropriate. Your entire written statement will, of course, be made a part of the record. You may summarize it or just however you would care to proceed.

STATEMENT OF WILLIAM PATRICK COLLINS, UNDER SECRETARY, U.S. DEPARTMENT OF ENERGY, ACCOMPANIED BY DONNA FITZPATRICK, PRINCIPAL DEPUTY ASSISTANT SECRETARY FOR CONSERVATION AND RENEWABLE ENERGY; AL STREB, DEPUTY ASSISTANT SECRETARY FOR CONSERVATION; AND DR. ROBERT SAN MARTIN, DEPUTY ASSISTANT SECRETARY FOR RENEWABLE ENERGY

Mr. COLLINS. Thank you very much, Mr. Chairman. I do have a statement and would like to have it go in the record in full and I will summarize.

I am accompanied today by Mr. Al Streb, the Deputy Assistant Secretary for Conservation and Dr. Bob San Martin, Deputy Assistant Secretary for Renewable Energy in the Department.

I appreciate this opportunity to appear before you today and provide information on the fiscal year 1986 budget request for the Department's Energy Storage Electric Energy Systems, and Small-Scale Hydropower Programs. The budget for these programs is consistent and, I think, supports the Fourth National Energy Policy Plan. The overall goal of national energy policy is to foster an adequate supply of energy at reasonable costs. The strategies for achieving this are to minimize the Federal control and involvement in energy markets, while maintaining public health and safety and environmental quality, and second, to promote a balanced and mixed energy resource system.

The fiscal year 1986 budget implements these strategies by supporting development of a mix of technologies that can contribute to energy supply and end-use energy efficiency. In allocating our resources we are concentrating on applying Federal funds only where they are most effective. In supporting research and development efforts where the potential payoff is high, but which private industry cannot be expected to pursue because the results are difficult to predict and return on investment would require an exceptionally long time to be realized. Our efforts will continue to focus on improved dissemination of our results of our R&D programs and on expanded collaboration with the private sector.

In support of these strategies, the Electric Energy Systems Program and Energy Storage Program provide vital links between energy supply, conservation and conversion and energy end use. The Hydropower Program provides a technology base needed to assist in reestablishing the U.S. small hydroelectric industry and has been extremely successful—one of the outstanding success stories, I think, in the last 7 or 8 years.

I'd like to address the fiscal year 1986 budget request for each of these program areas.

In the Electrical Energy Systems Program, we support the mid and long-term R&D in support of our national security interests and the reliability and safety of our future electric networks. The program's three main areas are the biological health effects associated with exposure to high-voltage electric fields, electric network reliability, and electric system efficiency. The fiscal year 1986 request for EES is $10 million.

The electric field effects request of $3 million will support the continued development of scientifically reliable information on the impact of exposure to high-voltage AC systems and DC ions in humans, as well as the human health and safety analysis. The reliability R&D budget request of $3 million will support continued research on the impact of a nuclear generated electromagnectic pulse on the nation's electric network, and research of advanced techniques for systems protection during major disturbances.

On the systems technology proposed budget of $3.6 million will primarily stress the documentation of research and transfer of this area's newly developed technologies, such as super-conducting cable and high-voltage direct current to interested parties.

The Energy Storage Program is the nucleus of all research activities related to advanced energy storage and conversion systems. The fiscal year 1986 budget request is $16.1 million for research in battery, thermal, and chemical hydrogen systems. The largest investment is in the battery area. Success in developing batteries for either load leveling or electric vehicles could result in a very significant reduction in U.S. petroleum consumption. The $12.5 million battery storage activity consists of technology base research and advanced development and testing. Technology base research encompasses fundamental research to provide a base for providing new batteries and improving systems under development. Activities in fiscal year 1986 in technology base research will include providing better understanding of the complex phenomena that limit performance of batteries and developing improved materials and components needed to advance energy storage technologies and developing new electrocatalysts to improve performance of electrochemical energy conversion systems.

Advanced development and testing includes the development and evaluation of advanced battery systems for mobile and stationary applications. Activities in fiscal year 1986 in advanced development and testing will include the development of sodium-sulfur batteries for vehicle and load leveling applications. This battery is capable of providing about five times the energy storage capability of lead-acid batteries. Evaluation of advanced battery systems is being done at the National Battery Test Laboratory.

Thermal and mechanical storage supports the effective use of thermal energy sources and the improved production and storage of hydrogen. The fiscal year 1986 budget request is $3.1 million for these activities.

In small-scale hydro, that represents a relatively mature technology. Therefore, DOE will rely greatly on the private sector for further advancements. Fourteen thousand and three hundred megawatts of underdeveloped sites appear to be feasible and environmentally acceptable and the current program objectives are to complete cost-shared demonstrations and technology development projects and transfer technical results to the private sector.

The fiscal year 1986 budget will insure continued monitoring of cost-shared demonstrations and engineering R&D projects. Thirteen demonstrations are now on line, with a total of 78.5 megawatts. For fiscal year 1986, three more demonstrations are expected to come on line: Cherokee Falls, SC, 3.9 megawatts, Great Falls, NJ, 7.5 megawatts; and Jackson Bluff, FL, 10.9 megawatts. In addition the Blue Marsh Dam, PA, prefabricated plant systems engineering R&D facility, at 1.3 megawatts, should be ready for operation and testing. We also plan to continue cooperation with EPRI for transferring lessons learned from demonstrations and feasibility studies.

In conclusion the budget submitted for fiscal year 1986, I think, represents a balanced and objective approach to achieving program goals and maintaining technological leadership in the areas of electrical energy systems, energy storage and hydropower and will substantially contribute to the base of technical information required for informed private sector decisionmaking.

Mr. Chairman, we are pleased to have the advice and counsel we have gotten from the members of this subcommittee and their staff and particularly for the opportunity to appear here today to talk about our program. Thank you.

[The prepared statement of Mr. Collins follows:]

Statement of

Pat Collins

Under Secretary

U.S. Department of Energy

before the

Committee on Science and Technology

Subcommittee on Energy Research and Production

U.S. House of Representatives

March 7, 1985

Madam Chairman and Members of the Subcommittee, I appreciate this opportunity to appear before you today and provide information on the FY 1986 budget request for the Department of Energy's Electric Energy Systems, Energy Storage, and Hydropower Programs. The budget for these programs is consistent with and fully supports the goals and strategies set forth in the Fourth National Energy Policy Plan (NEPP-IV). I will summarize those parts of the Plan which are relevant to the subject of today's hearing, discuss related highlights of the FY 1986 budget request, and address the areas of interest identified in your letter of invitation.

NATIONAL ENERGY POLICIES AND STRATEGIES

The overall goal of our national energy policy is to foster an adequate supply of energy at reasonable costs. This policy recognizes that "adequate supply" requires flexibility in the energy system, with no undue reliance on any single source of supply. The goal of "reasonable costs" suggests economic efficiency within the energy system, so that energy consumers, individual, commercial, and industrial users alike--are not penalized by economic rigidities introduced into the system by ill-advised governmental regulation. The strategies for achieving this energy policy goal are: (1) to minimize Federal control and involvement in energy markets while maintaining public health and safety and environmental quality; and (2) to promote a balanced and mixed energy resource system.

The FY 1986 budget request implements these strategies by supporting development of a mix of technologies that can contribute to both energy supply and improved end-use efficiency. We are concentrating Federal funds only where they are most effective: sponsoring research and development (R&D), where the potential payoff is high but which private industry cannot be expected to pursue because the results are difficult to predict or a return on investment would require an exceptionally long time to be realized.

In support of these strategies, the Electric Energy Systems Program and the Energy Storage Program provide vital linkages between energy supply, energy conversion, and energy end-use. The Hydropower Program provides a technology base needed to assist in reestablishing the U.S. small hydroelectric industry.

ELECTRIC ENERGY SYSTEMS

The Electric Energy Systems (EES) Program provides support for the continued research necessary to develop technologies and techniques for future electric energy supply and public health and safety. Specifically, the program is structured to: determine the biological health effects and risks to humans, plants, and animals exposed to high-voltage electric fields; provide technology options that will enhance the reliability of the nation's future electric network under all normal and emergency situations; and improve the efficiency of electric energy delivery systems through the development of new materials, advanced controls, and new design concepts. The FY 1986 request for EES is $10.0 million.

The electric field effects request is $3.0 million to continue research to establish an objective scientific data base for electric field effects. Efforts will continue to investigate the biological mechanisms at work to produce observed effects and develop a method to determine the impact of exposure to high-voltage d.c. systems and the inherent d.c. positive and negative ions on human respiratory systems and whole bodies. There continues to be substantive public concern over the suspected effects from exposure to high-voltage electric fields on humans. This research has produced a national resource of biological data and understanding and has been instrumental in supplying data to Federal regulators as well as public concern groups. Anecdotal references are being replaced with scientifically reliable information. Biological studies with laboratory animals have resulted in identifiable negative health effects.

Critical to the acceptance of the laboratory results has been the development of proper methods for epidemiological studies; of special interest is the development of methods for the assessment of risk to humans. Many of the experimental protocols have gained widespread acceptance in the scientific community, providing a credible basis for research evaluating relationships between exposure to electric fields and observed effects on animals.

A $3.0 million budget has been proposed for the Reliability R&D activity to continue research to assess the impact of a nuclear electromagnetic pulse (EMP) on the nation's electric network, to develop computer-aided technologies which will enhance power system performance during normal and abnormal operations, and to provide advanced techniques for control and protection of systems during major disturbances. For example, the response of the dielectric components of electrical equipment to waveforms such as those generated by lightning or switching surges is reasonably well understood. However, there exists limited information regarding breakdown phenomena when dielectrics are subjected to fast-rising pulses such as those generated by nuclear detonations. Current EMP-related research efforts include projects focusing on those features of nanosecond breakdown which distinguish it from processes occurring as a result of slower voltage changes.

Systems technology work in recent years has focused on technology development and equipment improvements for the electric power industry, of a type substantially supported by EPRI. The proposed budget for the Systems Technology research activity is $3.6 million. This budget level will be required to meet contractural obligations to terminate the current program. Terminating the Athens automation and superconducting cable and generator projects will require $1.6 million for orderly close-out. An additional $1.8 million will be required to phase out more than 30 contracts in the areas of high voltage direct current (HVDC) research, new materials, automation and processing concepts, failure mechanisms, and load leveling. The battery energy storage test facility performs product oriented work in verifying the performance of prototype and pre-production load leveling batteries. This work is of direct commercial interest and benefit to the electric power industry, and should be left to the industry. DOE support for the testing will be terminated and the facility and its equipment will be turned over to Public Service Electric and Gas Company of New Jersey for continuing use by the electric power industry. Other related but more long term battery work will continue in the energy storage program.

The Hawaii deep water cable project will be reshaped and limited in scope. Previous funds will be used to complete cable design fabrication with test cable and laboratory tests. Research data and results will be made available to the industry, technical libraries, and professional groups for future use.

ENERGY STORAGE

The Energy Storage (EST) Program serves as the nucleus for virtually all research activities related to energy storage within the DOE. The major goal of the program is to develop advanced energy storage and conversion systems that will facilitate the use of abundant but intermittent energy sources and increase the efficiency of energy use with a concommitant benefit to the energy economy. The FY 1986 budget request for the Energy Storage Program is $16.1 million.

The Energy Storage Division is currently pursuing three promising categories of energy storage technologies: battery (electrochemical), thermal, and chemical/hydrogen. Of these, the largest investment has been in batteries because of their potential widespread use in transportation, load-leveling for electric utilities, general industrial energy storage, and as an integral part of renewable energy systems. Success in developing a battery for either electric vehicles or load-leveling applications could result in significant reduction in U.S. petroleum consumption since the charging energy for the battery could be produced from coal or nuclear energy.

The battery storage program supports basic research and advanced development on battery systems which show potential to use in electric vehicles, renewable energy applications, and for electric utilities. The Energy storage program develops the technology base for use by industry and coordinates its efforts closely with other end-use application programs at DOE and the private sector.

The $12.5 million Battery Storage activity consists of technology base research and exploratory technology development and testing. The technology base research activities encompass fundamental research with the objective of providing the basis for improvements in existing battery systems and the identification and development of new batteries and fuel cells. In FY 1986 the aims of the technology base research will be to:

- provide a better understanding of the complex phenomena that limit the performance and lifetime of electrochemical systems,

- develop improved materials and new components required to advance or improve energy storage technology, and

- identify new, low-cost catalysts for electrochemical energy conversion systems.

These activities are essential to developing electrochemical energy storage devices with improved energy efficiency, lower capital cost, increased cycle life, and higher energy and power density.

In addition, the feasibility demonstration of the aluminum-air battery will continue in FY 1986. This battery is expected to provide up to 250 watt hours per kilogram (more than 6 times that of the improved lead-acid battery) and a range of 250-400 miles for a five-passenger all-purpose vehicle. This program was initiated in 1979 and the first refuelable, multi-cell module was successfully tested in 1982.

The objectives of the advanced development and testing activity include development and evaluation of high performance, long- life, economical batteries for future mobile and stationary energy storage applications. In FY 1986, the exploratory technology development and testing activities will continue to concentrate on sodium-sulfur batteries as well as battery testing and post-test analysis of other batteries. The feasibility of the sodium-sulfur battery, which has the potential for providing five times the energy storage capability of commercial lead-acid batteries, has been demonstrated. Program activities will emphasize development of low-cost abundant materials.

The Thermal and Mechanical Energy Storage activity is oriented toward providing the technical underpinning for the more effective use of thermal energy sources and improving the efficiencies of chemical/hydrogen production and storage. These technologies will permit energy conservation or fuel substitution in transportation and in residential and commercial buildings.

This $3.1 million activity will, in FY 1986, emphasize chemical/hydrogen research on high-temperature electrolysis and advanced storage options, such as refrigeration by adiabatic demagnetization, to achieve lower cost in hydrogen liquification. The thermal program will conduct research on form-stable phase change materials in the medium- and high-temperature range and explore advanced storage concepts and conversion techniques.

SMALL-SCALE HYDROPOWER

Small-scale hydropower production encompasses a broad range of technologies designed to harness the Nation's streams and smaller waterways as an environmentally acceptable and economically viable energy source. According to a study conducted by the U.S. Army Corps of Engineers, this resource base is sizable: 6,800 MWe of small hydropower are already installed, 14,300 MWe are available at undeveloped sites which appear to be feasible and environmentally acceptable, and an additional 14,900 MWe are estimated to be available at less favorable sites.

Since the inception of the DOE Small-Scale Hyropower Program in 1977, there have been a number of significant accomplishments. Thirteen demonstration projects with a total generating capacity of 78.5 MWe have been brought on-line. An additional six projects are underway with a capacity of approximately 53.7 MWe. Additionally, over 30 engineering research and development projects aimed at developing ultra-low-head and retrofit technology have been conducted, enhancing knowledge in areas such as pumps-as-turbines, marine thrusters as turbines, and cross-flow turbines. Environmental guidance manuals and methods for assessing minimum stream flow requirements were developed for use by FERC, state agencies, and hydropower developers. Thirty-four new hydropower projects were initiated by small developers as a result of the DOE Small Hydro loan program. Technical assistance was provided to 40 states. Finally, a major project was initiated jointly with the Electric Power Research Institute (EPRI) to transfer the new hydropower technology to industry.

The current objective of DOE's Small-Scale Hydropower Program is to concentrate on completing cost-shared R&D and technology development projects and implementing an effective technology transfer program that will support future hydropower development by U.S. industry.

The FY 1986 budget request for hydropower is $0.5 million which includes $0.45 million for technology support and $0.05 million for program direction.

Two projects are expected to begin operation in FY 1985. A 400-kWe cost-shared low-cost crossflow turbine, located at Arbuckle Mountain, near Redding, California, will be completed by the end of the fiscal year. The turbine and plant will be thoroughly tested, after which operation and maintenance data will be collected for two years. The 15 MWe Boott Mills technology development project in Lowell, Massachusetts, is scheduled to go on-line in August 1985. The Department also plans to cooperate with a university or industrial partner to continue the free-stream turbine concept through the field-testing stage. Initial studies and model testing by DOE have shown this to be a promising concept for use in swift-flowing streams without dams.

Four previously funded cost-shared projects are scheduled to go on-line during FY 1986: Power facility at Cherokee Falls, South Carolina (3.9 MWe), Great Falls, New Jersey (7.5 MWe) Jackson Bluff, Florida (10.9 MWe), and a Prefabricated Plant System engineering R&D project. This 1.3 MWe prefabricated plant, featuring siphon penstock, pumps-as-turbines, automated controls and modular construction, is currently planned for installation at the U.S. Army Corps of Engineers Blue Marsh Dam, near Reading, Pennsylvania. Successful installation and operation of the plant will be of major significance, because there are many similar Corps of Engineers dams which could be developed for hydropower. After initial operation and testing, this project will be monitored for a two-year operation and maintenance period.

The experience and data resulting from departmental hydropower R&D activities will be made available to industry in a timely manner. As part of our technology transfer effort, the DOE/EPRI Technology Transfer Project will publish reports on DOE-supported feasibility studies, licensing loans, and construction projects. A guidance manual for developers is also planned for publication.

CONCLUSION

The budget submitted for FY 1986 represents a balanced and objective approach to achieving program goals and maintaining technological leadership in the areas of Electric Energy Systems, Energy Storage, and Hydropower. Therefore, we ask that this budget request be given every consideration for funding at the levels requested.

Thank you for the opportunity to testify today.

U.S. Department of Energy
Assistant Secretary for
Congressional, Intergovernmental
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BIOGRAPHY

PAT COLLINS

Pat Collins was nominated by the President on June 21, 1983, and confirmed on August 5, 1983 as Under Secretary of the U.S. Department of Energy (DOE).

Prior to joining DOE, Mr. Collins served as Director of Political Affairs (1979-80), and Vice President of Political Affairs (1981-83) at the National Association of Home Builders. From November 1980 to January 1981 he was assistant to the senior advisor, Office of Executive Branch Management, Reagan Presidential Transition Team.

Mr. Collins was Administrative Assistant to Montana Congressman Ron Marlenee (1976-79), and Legislative Assistant to Texas Congressman Alan Steelman (1973-76). He was associated with the government relations and political consulting firm of Raymond V. Humphreys Associates during 1971-72.

Mr. Collins entered the military as a private in 1968. After graduating from Infantry Officers Candidate School, he continued his military education by completing Signal Officers School and the Kennedy Special Warfare School at Ft. Bragg. He was offered a position on the faculty of the Kennedy Special Warfare School but volunteered for duty in Viet Nam and served an extended tour. While there he served in several positions including the Operations Officer for the 8th Psychological Operations Battalion.

Mr. Collins grew up in Southwestern Montana and went to Carroll College in Helena from 1964 to 1967. He graduated with a B.A. degree in history from the University of Montana, Missoula, in 1968. Mr. Collins also attended the George Mason University School of Law in Arlington, Virginia, and did graduate work in business administration at the American University in Washington, D.C.

Mr. VALENTINE. Thank you very much, Mr. Collins. On page 3 of your testimony you stated that biological studies with laboratory animals have resulted in identifiable negative health effects. Could you elaborate on that a little bit and tell us a little bit more about what you're talking about there?

Mr. COLLINS. We're basically talking about four areas that we are concerned and that we are looking into and I'd like to ask Mr. Al Streb, our Deputy Assistant Secretary to go over those in detail, Mr. Chairman.

Mr. STREB. These—the studies on biological effect are, I would have to characterize, in rather early stages still at this point. It's my understanding that though we've observed behavioral effects in the laboratory animals there's really no evidence whatsoever that there is permanent biological damage. This program continues actually pursuing three separate avenues of research. One is the effect of electric field, second is the effect of magnetic fields, and third, the effect of DC ions. But at this point I really don't think that we can say that there is any evidence that there is permanent biological damage that we have observed to date.

Mr. VALENTINE. Where are these experiments, these experiments that we're just talking about, where are they conducted?

Mr. STREB. Part of the work is being done at Pacific Northwest Laboratories; Southwest Research Institute is also one of our participants in the program. There is some work at Oak Ridge National Laboratory in Tennessee, there is work at Carnegie Mellon, and the National Bureau of Standards.

Mr. VALENTINE. How much of this requested $3 million effort will be devoted to the biological health effects research?

Mr. STREB. Well, I think it basically is all devoted to biological health effects. It's in understanding the effects of these various electrical or magnetic fields on the animals and then observing, over a long period of time, the effects in terms of cellular damage or any other damage that could be detected.

Mr. VALENTINE. What is the status, Mr. Collins or either of you gentlemen, the status of the planned move of the electric energy systems and energy storage systems from conservation to renewables.

Mr. COLLINS. Mr. Valentine, that's part of the reorganization that we have going through the Federal system, and it should be completed, I think, within 60 days. We've been working on that for about 8 months and going through the variety of hoops that you have to go through in the Federal system on that.

Mr. VALENTINE. A reduction of 50 percent in the activity involving electric energy systems would significantly alter program activities. These activities in which the DOE was a partner with non-Federal interest. which ones are ready for commercialization, if any?

Mr. COLLINS. Well, Mr. Chairman, in the Energy Department and Conservation and Renewable area, I would say that this is probably our boldest effort to see if we can get the private sector involved. And I—and quite frankly our previous secretary, Don Hodel, had a great deal of experience with the electrical industry and felt that it was appropriate that much more of this was either more extensively cost shared or actually taken over by EPRI or other groups like that in the electrical energy business. I'm not sure we're going to be able to do all of that, I'll be candid about that, but we think that we ought to make an effort at that. And we have a variety of systems that are relatively mature. We have some that we think can be transferrable and we have some that in the battery areas, extensively in the battery area, quite frankly some that don't look like they're going to be winners, and I think industry has made that conclusion. And so that's why we basically identified two batteries that we're going to pursue and leave the rest for the private sector to make a decision whether they want to adopt those as well. Would you like to add anything to that, Al?

Mr. **Streb**. No.

Mr. **Collins**. OK.

Mr. **Valentine**. Directing your attention to this fascinating area, not that it's not all fascinating, but to me a more fascinating area, how does—how do we really—or can we really expect a breakthrough in an area of energy conservation. I saw stories, which have vexed scientists for many years, on the battery, you know, that it would take, I suppose, a van pulled behind the electric car to get enough energy for it to go 20 miles an hour for 20 miles.

With reference to this battery research and development, in your opinion, what level or performance is needed in order to provide an energy source for electric vehicles which would be commercially viable? Are we really close to that sort of thing?

Mr. **Collins**. I think so, Mr. Chairman. And of course that's relative in years, but I think we're going to probably have to have at least 100 miles that we can depend on. We have some work being done with, for example, ITT Baking and others and some battery work, and I went over this last year with the officials of that company and quite frankly they were in the 60, 65 mile range. That's not quite good enough. There are certainly routes, for example, delivery routes in Chicago that only go 3 miles and, of course, this is very helpful when you have an environmentally acceptable system like batteries to have that downtown in a place like Chicago. But, we think you need to get to 100, to probably a minimum of reliability of 100 miles. In the aluminum-metal battery it looks like it has a potential of 250 miles and that is very promising. Of course, also in sodium-sulfur we were able to carry about five times the load that we have in lead-acid and batteries before. So both of those look very promising and like I say, the conclusion by ITT and others where that they have about 60, 65 miles reliability right now and that's not quite enough. This was at California, where I was at, for their overall fleet and, of course, it's extremely difficult when you get into areas in the Northwest and in the West in general where you need a great deal more mileage.

Mr. **Streb**. Mr. Chairman, I could add that we have, addressing specifically the transportation application of storage, there is also a Transportation Electric and Hybrid Vehicle Program, which is not under the jurisdiction of this particular committee, for which we're asking about $6.5 million for 1986. A little over 50 percent of that is in near-term battery technology, so what you see in the Energy Storage Program is not the only effort that we have in electrochemical storage.

Mr. VALENTINE. As we have developed, in this country, sometimes with the help of the Congress, and sometimes despite, maybe, Congress, we have of course achieved a real composite miracle in industrialization, but with that goes certain centers of interest and power. This—the development of this type of battery would play havoc with those who sell petroleum products in this country and who manufacture all automobiles and understandably so. Do you have any comment that you'd like to make, Mr. Collins or either or you other gentlemen, with respect to whether or not we really are doing all that we can in this area with the tools that we have, with the revenue that is set aside for this purpose? Or could we, with an additional investment, maybe come closer to this real workable electric automobile that some might not really like to see within the next few years?

Mr. COLLINS. Well yes, Mr. Chairman, I think that certainly we could accelerate some of these programs. Some of the milestones we're stretching out, I'll be very candid about that. And in, for example, England, they do have an assembly line production of electric vehicles and the way we approach it at the Department of Energy on our mixed and balanced system is we pursue all alternatives. The stated goal here is a substitution for petroleum and that's why we are pursuing these types of technologies.

It could be a bit faster, that is correct. It's a real tough question on how far you go in research before the private sector can make a go or no-go decision and probably we're being bolder in this area than anyplace in our Conservation and Renewable Programs in the Department of Energy this year to see if we can get more cost sharing with the industry and more participation by them.

Mr. VALENTINE. Mr. Morrison has to depart in a minute or two, so I'll recognize him at this time.

Mr. MORRISON. Thank you very much, Mr. Chairman.

I have a concern as I look at some of these budget figures and seen for instance, electric energy system cut in half from fiscal 1985. I have a specific question on the biological health effects of exposure to high voltage transmission lines, since my district seems to be a favorite corridor for this sort of installation.

What are your plans for the out years in this particular study arena?

Mr. COLLINS. Mr. Morrison, it's a very steady, slight increase over the next 5 years in this area, but I do think that we're extremely flexible. We may find significant problems that we don't know of now. We may find answers much quicker than we think we are. I've talked with several foreign officials and, of course, they're greatly concerned because they have actually, in many countries, housing underneath these lines, like we don't have here in the United States. But it is a steady and increased projection in the out-years.

Mr. MORRISON. With the only anticipated future reductions being when you find some answers?

Mr. COLLINS. Find some answers or find out that there are no permanent effects, as Mr. Streb has suggested. In certain areas—there are a great many news stories. I think that you're well aware of, as are others, about potential effects and we're concerned and we're pursuing it with animals, and we don't have a great deal of research. We don't have a long-term research there and so far, as Mr. Streb said, we haven't found any permanent problems, but we're particularly zeroing in on three or four areas that have been cited most popularly in the press.

Mr. MORRISON. OK, I appreciate the assurance that this is a priority program. Just one other question before I head out to testify on nuclear waste. In my opening statement I commented on something that I think is vitally important and should be to this subcommittee and that is some sort of a feel that you're confident that where there are reductions in some of these programs, which obviously project priorities in the past, that the private sector is there not only willing, but able to pick them up as we look at this overall policy of continuing to recognize the need for expanded electrical systems.

Mr. COLLINS. That is a very difficult call, Mr. Morrison. As I say, we're being bolder here than anyplace else in the Conservation and Renewable areas in the Department of Energy. We know, for example, with present funding levels, with different organizations like EPRI that they'll be able to maintain some facilities and, of course, they would have to reorder the priorities within their organization. We're going to work with them and consult, but I don't think this is locked in cement. I don't hesitate to come back and ask this subcommittee and others for a supplemental if we need it in certain areas because the private sector is not going to be able to take over the type of cost sharing that we would like them to do. We're very flexible on that.

Mr. MORRISON. OK, we'll find out later, I guess, how flexible you'll need to be.

Mr. COLLINS. That's right.

Mr. MORRISON. Thank you very much, Mr. Collins.

Mr. COLLINS. Thank you.

Mr. MORRISON. Thank you, Mr. Chairman.

Mr. VALENTINE. Mr. Stallings, do you have questions?

Mr. STALLINGS. Just a couple. What is the interest of the private sector now in the energy areas that you're concentrating on? Is it higher than it's been in the past few years? Has it dropped since the oil glut seems to be with us?

Mr. COLLINS. It certainly is driven by price, Mr. Stallings, and I think that we are concerned that some people are taking their eye off the conservation goal and the energy efficiency opportunities because of their perception of the cost of petroleum right now. We've always felt and approached it like that, that's very cyclical. It could come up precipitously, and we're trying to keep everybody's attention there and we're trying to keep their participation there. It is difficult, everyone being strapped for money as they are.

I think that, however, what we have found is that there is some permanent long-lasting conservation effect from the price shocks of 1973 and 1974, and basically we are actually using less than we did, on a percentage basis, in 1973. That's very positive and I don't see any reason we can't continue to get our overall 2 percent reduction a year. But, we're going to have to have a great deal of education, awareness, and technology transfer to keep that schedule going, I think.

Mr. STALLINGS. What has been the trend in the last couple of years? Is there more energy consumption as we get further and further away from those energy shocks?

Mr. COLLINS. Well, we've had the slight increase in energy consumption, and of course, in the Federal Government, and we have a 656 committee for overall energy conservation. Of course the Defense Department's new requirements have increased that within the Federal Government, and our progress is not as high a percentage as in the last year or so as it was before. And I think that at the same time our energy efficiency is coming online to the point where we have about 200 companies now selling energy efficient products, although the top 2 still have about 70 percent of the business, and the awareness. And one of the reasons that the President proposed that we increase the budget in technology transfer 500 percent last year, which the Congress generally accepted, was, I think, so that we can get the word out to the ultimate consumer, which we have to do in our type of a society, so he can ask the entrepreneur for the type of products that our research has come across with. I don't think that we have very good coverage in getting the word out about what's available to the consumer, and that's what we're concentrating on.

Mr. STALLINGS. On page 2 of the testimony you discuss the DOE position of supporting high-risk, long-term research, which wouldn't ordinarily be pursued by private industry.

Mr. COLLINS. Yes.

Mr. STALLINGS. Of the projects that which will be terminated if the budget reductions are enacted, which of these are ready to be turned over to the private sector or will the private sector take any of them?

Mr. COLLINS. Well, we think several are. We think several are at the point where they will choose to reject and then some are a tough judgment call in the middle. I'd like to have Mr. Streb outline those if he'd like to specifically.

Mr. STREB. The area which is hardest hit in the budget request relative to last year is certainly in the area of electric energy systems. That can be partitioned into three areas: The biological effects, the electromagnetic pulse effects, and in both of those cases I think it's clear that there would be no—there's little or no private sector interest. And we are maintaining both of those programs, though not quite as high as they have been in previous years, but very close to it—about a 25 percent reduction in which we think we can maintain a viable program.

The real question is with respect to the electrical equipment and electrotechnology area. And in that area a good part of the previous expenditures have been in the deepwater cable, the Hawaiian cable. There, as a result of a relative slowness in the operation of that program by the participants there's a fair backlog of money. We can maintain that program. We intend to alter its ultimate objectives to carry it only to the point where there would be a prototype produced.

Other areas of technology are the automated control system for electrical networks. We will be required to cut the program that we had planned short. We intend to leave the program in a state, with the Athens Utility District, so that it can be operated by them and hopefully the results will be sufficiently successful that there will be private sector interest to pick it up.

The system development is largely done. We, as a result of this budget, are not carrying it as far forward or participating as long as we had previously planned. The one other area that comes to mind is in the superconducting technology, we are—of the funds which are available, $3.6 million in the technology area, a good part of it is being placed there in order to wrap up, in effect, the results of the work that has been done so far and to make it available for private sector continuation, if they so desire to do so.

Mr. COLLINS. Mr. Stallings, you can carry that further. To give you specific examples, in the Hawaiian deepwater cable operation we've had about $10 million. They've expended $3 million of that. They're redesigning. They're about 1 year behind on that and we've had one company show some interest in technology transfer and moving that to other places.

In the Athens project, once again the local municipal district indicates it does not have the funds, but interestingly enough, EPRI indicates it does not have the interest. So, that sort of gives us an indication of maybe how much further we should pursue some of these.

Mr. STALLINGS. Thank you. Thank you, Mr. Chairman.

Mr. VALENTINE. Thank you, Mr. Stallings.

Mr. Collins, does this small-scale hydropower project, does it involve situations like where a homeowner or a owner of a farm would undertake to construct or purchase a waterwheel and generate his own electric power and so on? I'm interested in that because I was—many years ago my father's dream was that sort of thing and I remember going with him at night to work on a water—he was a country lawyer, as I was, and he built this waterwheel at night and he installed it behind the house and had the ditches dug and that sort of thing and when the depression finally caught up with him that thing had got to the place it would gush out water in the backyard of our home, in spurts like that. It never got to the place where it translated that into a process that would create electricity. But, are we talking about encouraging that same sort of thing here and to what extent? Do these 780 preliminary permit applications, could some of them be to a person like that on a farm or are they larger operations?

Mr. COLLINS. Absolutely, Mr. Valentine. I'm from a rural community in the West, and I'm familiar with that, too, and it's one of the great success stories, basically. In 1977 there wasn't much being done. We've talked about 1,000 to 1,500 either permits or licenses being filed with FERC a year for the last 2 or 3 years. That's how much it has grown. Our research is right now of a very simple run of river system that certainly would fit into the smaller applications, and the cross-flow turbine. I think really at this point, although we will complete those, it mainly will be into this type of technology transfer and be able to share the information with farmers and ranchers and others that may want to pursue that. One of the systems to do that was the money we spent in technology transfer last year to put in an 800 number so that they can call in and get information about the technology that would be available for their type of operations.

Maybe Dr. San Martin might have some more to add to that.

Dr. **San Martin**. Mr. Chairman, you were right on with regards to explaining the potential places where you could actually have these types of applications—everything, running from an individual residence to a municipality, to a powerplant. What we've concentrated on in these programs are systems that are 30 megawatts in size and smaller, with a lot of concentration in the smaller ones. As Mr. Collins pointed out, we've been very, very proud of the success stories that have taken place here, and the general interest that is continuing in the country, and additional development taking place. As long as we can continue to try and develop a little bit more modern technology, and supply those that are interested with the most up-to-date information so that they can make informed decisions, I think that we will continue to see the success and further development of these small-scale hydropower systems.

Mr. **Valentine**. Are you satisfied really with what has been accomplished at this point and what about the participation of the private sector?

Mr. **Collins**. Well—excuse me, Mr. Chairman.

Mr. **Valentine**. I'm finished—well, I will add this: Are there businesses operating in this country that seriously manufacture these outfits, the waterwheels and cooperate with you and you with them to move this product along. It seems to me that it's kind of like the use of renewable energy supplies or burning wood and I think we did a great thing in this country. Of course it lead some of us—it lead me to great economies, first a fireplace insert and then a chainsaw and then the purchase of a farm which had trees on it and the purchase of a pickup truck, but you know, I'm saving a lot of gas and oil. Could we—would this really be some meaningful improvement, especially in rural America?

Mr. **Collins**. I think so, Mr. Valentine. It has been a great success story and, as a matter of fact, it is now getting down to the smaller, individual type of activities that you're discussing. I think that many of the farmers and ranchers are looking at this and others. I don't know how many companies that may be involved in that. Do you, Bob?

Dr. **San Martin**. Mr. Chairman, from the perspective of the industrial base that support these developments, many different companies are involved. Of course if you're siting and building a new small dam, for instance, you have the typical construction firms, of which there are many qualified such firms in the country who would aggressively pursue that. You've got other types of controls and specialty pieces of hardware, which are easily available. The one area that we have observed, which still exists today, is the actual power conversion device that is the rotating turbine or whatever device is used. We have not had, over the last several years, overwhelming interest by a significant number of U.S. companies; in fact, there's only one or two. In fact, European and Japanese companies have been exploiting that part of the hardware and have had a good deal of success in selling equipment in the United States.

Mr. **Valentine**. I was going to ask you that question and I will ask you and then we'll move on with this to other witnesses, unless somebody else has something else they want to say or ask about it, Mr. Stallings. I was going to ask you this, and I will, to what extent have other countries been involved? Say Japan or more particularly in Europe where we think of Norway, Sweden, Denmark, a supply of large rural area, wetlands, a lot of water, to what extent are other countries involved in this particular sort of thing?

Dr. San Martin. Yes sir, they've had a good number of successes in those countries also in deploying these small hydropower systems, and I believe that in some ways we've learned from their experiences and in other ways they've also learned from our experiences. I think we're doing a good job of primarily having an overwhelming impact and supply coming from U.S. industry to U.S. projects. It's only in that one area of the actual power conversion unit, the turbine itself, where we find the majority of the systems being sold in the United States, being supplied by foreign manufacturers.

Mr. Valentine. Thank you very much, gentlemen.

Mr. Collins. Thank you very much, Mr. Chairman.

Mr. Valentine. The next panel of witnesses consists of Dr. Charles Lawrence, representing the Institute of Electrical & Electronics Engineers, Inc., Mr. Lowell Endahl, have I pronounced—Endahl, from the National Rural Electric Cooperative Association and Mr. Gene Mannella, from the Electric Power Research Institute. We, of course, welcome you gentlemen today and I will remind you that we can—you can summarize your statement, what you have presented to us will appear in the record and you can summarize it or read it or proceed any other way that you deem appropriate. We're glad to have you.

Dr. Lawrence and gentlemen, welcome, we are ready when you are.

STATEMENT OF DR. CHARLES W. LAWRENCE, INSTITUTE OF ELECTRICAL & ELECTRONICS ENGINEERS, INC., ACCOMPANIED BY WILLIAM LANG, CHAIRMAN OF THE INSTITUTE OF ELECTRICAL & ELECTRONICS ENGINEERS, INC.

Dr. Lawrence. Mr. Chairman, members of the subcommittee, my name is Dr. Charles W. Lawrence and I thank you for the opportunity to appear before you today on behalf of the energy committee of the institute of Electrical and Electronics Engineers, known as IEEE. With me is Mr. William Lang, who is chairman of the Energy Committee.

The IEEE is the world's largest technical professional society with over 260,000 members worldwide, more than 215,000 of whom live and work in the United States.

The IEEE has an official Institute position paper on "The Role of Electricity in the U.S. Economy" which has emphasized the fundamental importance of energy availability to the welfare and economic health of the society. I had noticed from the previous questioning of the witnesses, questions on relative energy consumption increasing and the role electricity plays in that. We will find that electricity assumes a more and more dominant position in the overall use of energy in the United States. Our position recommends an increased role for electricity in the Nation's energy economy and calls for the increased support for other research and development programs to improve electric power system efficiency and reliability as well as to provide advanced energy conversion technologies.

The IEEE has consistently supported the Electric Energy Systems and the Energy Storage Program in testimony before congressional committees having oversight over its budget. We strongly support continuation of these programs. A lasting commitment to research in such a complex and critical area is essential. Continuity of research is espoused by the majority, but keeping both Government and industry involved in a consistent way is not simple. We do not live in a time of instantaneous inventions and instantaneous rewards. Advancing technology requires hard, patient, and deliberate efforts over an extended period. Further, to advance technology in this modern world requires significant investment in people and capital resources. It cannot be attacked with vigor in 1 year or in 1 administration and then abandoned totally in the following. Because of the importance of safety and reliability in electricity supply, many technologies must be demonstrated at or near commercial scale in order to be acceptable to the electric industry. Sharing the risk on these projects and providing funds for the construction of such facilities is a particularly difficult problem when budgets change dramatically from year to year.

We have reviewed the current program plan and are concerned that the lack of proposed funding may severely curtail ongoing research efforts from reaching a successful conclusion. Clearly the reduction in funding from $40.1 million to $26.1 million will have a detrimental impact on program administration, continuity, and coordination. The idea of an appropriate Government support of long-term, high-risk research is severely compromised by extreme shifts in funding levels. However, the current DOE administrators seem to have a sound understanding of the needs and of the funding required to meet these needs. We applaud this. We urge this commitment to research in the electrical energy area be consistently followed in the future.

Studies in the electric field effects for which the Congress provided increased funding in last year's budget, are again facing reductions in fiscal year 1986. This is most unfortunate because public concern is every growing over the health related effects of electric fields and a reduction in funding will certainly not permit any new research. In fact it will result in a slowing down of current activity. This will come at a time when many State legislatures are considering some form of future standards limiting electric field effects on humans. Such standards, conceived without adequate research and technical foundation, which the current DOE program is seeking to establish, would be most detrimental to the public benefit and the business economy. Furthermore the new work recently begun in magnetic field and DC ion propagation will have to be substantially deemphasized. It is the responsibility of the Federal Government to provide sufficient and unbiased information on biological effects of electric fields.

Similarly the proposed fiscal year 1986 budget would severely reduce the investigation into the performance of power systems and equipment under the affect of electromagnetic pulses. These pulses could be generated by nuclear blasts at high altitude in which no physical ground damage may be visible, but could produce not only a wide disruption of electric system continuity with resultant economic and public chaos but also a serious threat to national security. There is insufficient knowledge on these waveforms and their behavior on systems and equipment. Insufficient funding is being provided to carry on any new effort and even more importantly, very importantly, precludes any testing from being made of equipment under these very adverse transient conditions. The testing process is obviously a very necessary part of the research, but it's a costly thing to do.

Another example of losing the use of an expensive research tool, expensive in the sense in previous years it was built and still exists, is the Battery Energy Storage Test Facility, or as we call it, BEST facility. This facility enables testing of new advanced battery types under realistic conditions. The BEST project has not been budgeted for any operating funds in fiscal year 1986, and yet the need for developing and testing new battery—new advanced battery types has not diminished. New battery types, which are more efficient and cheaper, are needed for electric load leveling and for electric vehicles of the future. Zinc-chloride batteries have just gone through extensive testing procedures and the even more promising sodium-sulphur battery has just been scheduled to be tested. Currently the private sector is already supplying 60 percent of these operating funds and it is rather unlikely the private sector can assume a greater share of the operations without in turn curtailing other necessary research activities in other areas.

Systems research R&D is needed to provide options for future electrical networks, which will improve regional energy exchange and enhance essential service continuity during regional and national emergencies. The systems technology area, unfortunately, is the hardest hit in the proposed fiscal year 1986 budget. This program includes high voltage DC research, new materials for use in power systems, that is to say being used 20 years or more in the future, of magnetic, dielectric or semiconductor nature. In fact in one of these areas, power semiconductor technology, the technology in essence is being surrendered to foreign competitors, and there is a real need to make a serious effort to regain this U.S. technological leadership in this field. Now, DOE had planned to initiate a multiyear program to help in regaining this lead. However, inadequate fiscal year 1986 funding will cause these efforts to be aborted, they'll never get started.

In summary, one must not lose sight of the hard facts of research: from the inception of the research program to commercial viability, a project may take 10 to 15 years to complete. We must be working today for systems to be available for commercial use in the next decade. The Electric Energy Systems and the Energy Storage Programs are both concerned with crucial developments. It will require adequate leadtimes and continuity of funding through the whole R&D cycle to achieve these goals. Research activities that can provide benefits to public health, national security and the economic viability of our electric utility manufacturing industry, Mr. Chairman, are clearly deserving of serious consideration for additional funding in fiscal year 1986.

Thank you, sir.

[The prepared statement of Dr. Lawrence follows:]

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STATEMENT

BY

DR. CHARLES W. LAWRENCE

On Behalf of the
ENERGY COMMITTEE

of the

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS

on

ELECTRIC ENERGY SYSTEMS & ENERGY STORAGE SYSTEMS

Before the

SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION
HOUSE SCIENCE AND TECHNOLOGY COMMITTEE

March 7, 1985

My name is Dr. Charles W. Lawrence and I thank you for the opportunity to appear before you today on behalf of the Energy Committee of the Institute of Electrical and Electronics Engineers (IEEE). The IEEE is the world's largest technical professional society with over 260,000 members worldwide, more than 215,000 of whom live and work in the United States.

The IEEE has an official Institute position paper on "The Role of Electricity in the U.S. Economy" which has emphasized the fundamental importance of energy availability to the welfare and economic health of society. This position recommends an increased role for electricity in the nation's energy economy and calls for increased support of research and development programs to improve electric power systems' efficiency and reliability, as well as to provide advanced energy conversion technologies.

The IEEE has consistently supported the Electric Energy Systems and the Energy Storage Program in testimony before Congressional Committees having oversight over its budget. We strongly support continuation of these programs. A lasting commitment to research in such a complex and critical area is essential. Continuity of research is espoused by the majority but keeping both government and industry involved in a consistent way is not simple. We do not live in a time of instantaneous inventions and instantaneous rewards. Advancing technology requires hard, patient and deliberate efforts for an extended period. Further, to advance technology in this modern world requires significant investment in people and capital resources. It cannot be attacked with vigor in one year or one administration and abandoned totally in the following. Because of the importance of safety and reliability in electricity supply, many technologies must be demonstrated at or near commercial scale in order to be acceptable to the electric industry. Sharing the risk on these projects and providing funds for contruction of such facilities is a particularly difficult problem when budgets change dramatically from year to year.

We have reviewed the current program plan and are concerned that the lack of proposed funding may severely curtail ongoing research efforts from reaching a successful conclusion. Clearly the reduction in funding from $40.1 million to $26.1 million will have a detrimental impact on program administration, continuity and coordination.

The programs are designed with a knowledge of the energy requirements of the United States and the mandated rules of funding research given by the Department of Energy. The guidelines for what is appropriate for active government support are well articulated. The government involvement is principally focused on areas that are crucial to the economic well-being and security of the nation and which are high-risk and long-term research areas. These areas cannot or will not be attempted by non-government entities. Industry, principally through the Electric Power Research Institute (EPRI) is focused through its members to place emphasis on the solution of near-term problems. Manufacturers generally have not supported long-range high-risk research, which yields no immediate payback or profit. Most require a return on their research investments within five years or less. Tax structures, foreign government-supported competition, and the growing cost-price squeeze all tend to limit manufacturer research support. Any such research that does exist is directed toward improvement of existing lines of equipment in which they have a heavy investment. Internally supported research on new technologies, or on systems-related problems, is virtually nonexistent. Utilities' support of research is limited not only by their current financial strait, which is increasingly severe in some regions of the country, but also by regulation and local rate based pressures, and is generally limited to solution of their own immediate problems and the support of EPRI.

The idea of an appropriate government support of long-term, high-risk research is severely compromised by extreme shifts in funding levels. However, the current DOE administrators seem to have a sound understanding of the needs and of the funding required to meet the needs. We applaud this. We urge that this commitment to research in the electrical energy area be consistently followed in the future.

Studies in electric field effects for which the Congress provided increased funding in last year's budget, are facing reductions in FY 86. This is most unfortunate because public concern is ever growing over the health related effects of electric fields and a reduction in funding will certainly not permit any new research; it will result in the slowing down of current activity. This will come at a time when many state legislatures are considering some form of future standards "limiting" electric field effects on humans. Such standards conceived without adequate research and technical foundation, which the current DOE program is seeking to establish, would be most detrimental to the public benefit and business economy. Furthermore, the new work recently begun in magnetic fields and DC ion propagation will have to be substantially de-emphasized. It is the responsibility of the federal government to provide sufficient and unbiased information on the biological effects of electric fields.

Similarly the proposed FY 86 budget would severely reduce the investigation into the performance of power systems and equipment under the affect of electromagnetic pulses. These pulses could be generated by nuclear blasts at high altitudes in which no physical ground damage may be visible, but could produce not only a wide disruption of electric system continuity with resultant economic and public chaos but also a serious threat to national security. There is insufficient knowledge on these wave forms and their behavior on systems and equipment. Insufficient funding is being provided to carry on any new effort and precludes any testing from being made of equipment under these very adverse transient conditions. The testing process is obviously a very necessary part of the research, but it is a costly thing to do.

Another example of losing the use of an expensive research tool is the Battery Energy Storage Test (BEST) facility. This facility enables testing of new advanced battery types under realistic conditions. The BEST project has not been budgeted for any operating funds in FY 86 and yet the need for developing and testing new advanced battery types has not diminished. New battery types which are more efficient and cheaper are needed for electric utility load leveling and for electric vehicles of the future. Zinc-chloride batteries have just gone through extensive testing procedures, and the even more promising sodium-sulphur battery has been scheduled to be tested. Currently the private sector is supplying 60% of these operating funds and it is rather unlikely the private sector can assume a greater share of the operations without curtailing other necessary research activities.

Systems engineering R&D is needed to provide options for the future electrical network which will improve regional energy exchange and enhance essential service continuity during regional and national emergencies. The systems technology area is hardest hit in the proposed FY 86 budget. This program includes high voltage DC research, new materials for use in power systems (from 20 years or more into the future) of magnetic, dielectric, or semi-conductor nature. Power semi-conductor technology is being surrendered to foreign competitors, and there is a real need to make a serious effort to regain U.S. technological leadership in this field. DOE had planned to initiate a multi-year program to help in regaining this lead, however, inadequate FY 86 funding will cause the efforts to be aborted.

In summary, one must not lose sight of the hard facts of research: from the inception of the research program to commercial viability, a project may take 10-15 years to complete. We must be working today for systems to be available for commercial use in the next decade. The Electric Energy Systems and the Energy Storage Programs are both concerned with crucial developments. It will require adequate lead times and continuity of funding through the whole R&D cycle to achieve their goals. Research activities that can provide benefits to public health, national security, and the economic viability of our electric utility manufacturing industry are deserving of serious considerations of additional funding in FY 86.

Thank you.

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Teaneck, New Jersey 07666
Phone: 201-836-8074

Education

Ph.D. (Energy Conversion) Polytechnic Institute of New York - 1965
M.E.E. (Electric Power) Polytechnic Institute of New York - 1957
B.S.E.E. School of Engineering, Columbia University - 1954
A.B. Columbia College, Columbia University - 1953
Registered Professional Engineer in New York and New Jersey.

Professional Experience

Executive Director, New Jersey Energy Research Institute. July 1977-Present

Reporting to a 28 member Board of Trustees drawn from the private sector, universities and state government, the Executive Director functions to identify significant areas for energy research, forms research teams, develops proposals, institutes funding procedures, and maintains monitoring over the projects. Relations with state legislature, U.S. Government agencies and the U.S. Congressional Delegation are maintained. His responsibility is also to initiate and form study teams, or steering committees in critical areas, i.e., Assistance to Cities managed by Black Mayors, Hazardous Waste Task Force, Cogeneration and Alternate Energy, Solid Waste Task Force.

Some of the major projects instituted by the Executive Director which are now complete are the City of Trenton ICES - (Integrated Community Energy System), an urban renewal cogeneration system in downtown Trenton; Energy Use Pattern Study in Park Plaza Building, Newark - a thorough two-year study on a fully instrumented private sector building; Energy Integrating Master Plan for the city of Atlantic City - a plan which integrated energy considerations into the Master Plan worked out by the city.

Energy Research Consultant December 1975 to June 1977

1. Brooklyn Union Gas Company - Established a research and development program in new energy services (other than traditional gas distribution) to cut future energy costs.

2. U.S. Government ERDA, Washington, D.C. Program Manager, Office of Conservation. Implemented programs to overcome institutional constraints in organizing energy conservation programs at state and local government levels, and in the private sector banking industry.

Public Utilities Specialist, City of New York September 1970-November 1975

Executive Director of the Mayor's Interdepartmental Committee on Public Utilities formed by John V. Lindsay in September 1970 to be the city's own energy and public utilities policy-making body. It was composed of the seven key administrators and commissioners of his cabinet. In addition to managing the day-by-day activities of the Mayor's Committee, maintained liaison with

Professional Experience cont'd.

the utilities operating in New York City: Con Edison, Brooklyn Union Gas, New York Telephone, and the Power Authority of the State of New York. Testified regularly before legislative bodies, i.e., City Council, Public Service Commission, Federal Power Commission, and committees of the U.S. Senate.

As the city's resident energy research director, Mayor Lindsay assigned the responsibility to the Public Utilities Specialist to develop awareness in the energy problems confronting the city's business and industrial communities, and to assist them in undertaking energy research in conjunction with the universities in the city. These activities led to the New York Board of Trade establishing a Committee on Energy and Environment, and the Real Estate Board of New York establishing a Committee on Energy and Public Utilities. Assisted in obtaining grants and contracts from FEA and ERDA to sponsor much of the ongoing work of these committees.

Professor of Electrical Engineering — June 1961 to August 1970
City College of New York

Teaching position in energy conversion and electric power. Also held administrative position as Assistant Dean of Summer Session from 1965-1970.

Associate Professor of Electrical Engineering — September 1964 to August 1969
New Jersey Institute of Technology

Developed several new graduate courses in energy conversion and rotating machinery.

Research Engineer - Advanced Engineering — August 1960 to September 1961
General Electric Company, Steam Turbine Div. Schenectady, N.Y.

This employment was in the form of a fellowship to enable research to be done for the doctoral dissertation with all rights retained by General Electric.

Instructor in Electrical Engineering — September 1956 to August 1960
Polytechnic Institute of New York

Subjects taught were in electric circuits and networks, and general energy conversion. During this time, completed course-work for Ph.D.

American Electric Power Company, New York, N.Y. — September 1954 to August 1956

Charles W. Lawrence, Ph.D.,P.E.
Page 3

Professional Activities - Societies

Member of IEEE Energy Committee of the United States Activities Board.

Chairman of the Communications Subcommittee of the IEEE Energy Committee.

Member of the IEEE Synchronous Machinery Subcommittee of the Rotating Machinery Committee.

Member of the New Jersey Science Advisory Board.

Member of the National Task Group of the Urban Environment of ASHRAE.

Member of the Joint Committee on Tall Buildings.

Member of the National Energy Foundation, and co-founder of the Student Exposition on Energy Resources (SEER).

Past Vice-Chairman of the Committee on Energy and Environment for the New York Board of Trade.

Former Member of the Executive Committee for the Energy and Public Utilities Committee for the Real Estate Board of New York.

Former Advisor to the Citizens for Clean Air.

Former Advisor to Consumers Union.

Mr. VALENTINE. Thank you very much, Dr. Lawrence. I believe we will proceed with all the testimony before we go to the questions. Mr. Endahl, we'll hear from you at this time.

STATEMENT OF LOWELL J. ENDAHL, MANAGER OF ENERGY RESEARCH AND DEVELOPMENT, NATIONAL RURAL ELECTRIC COOPERATIVE ASSOCIATION

Mr. ENDAHL. Thank you, Mr. Chairman. Mr. Chairman and members of the committee, my name is Lowell Endahl, I'm manager of Energy Research and Development for the National Rural Electric Cooperative Association. NRECA is a nonprofit consumer-owned rural electric system that serves approximately 1,000 member systems which deliver power to about 25 million people in rural America, in the sparsely populated areas of this country and in 46 States. They are located in 2,600 of the Nation's 3,100 counties and—and these systems own and operate about 44 percent of the miles of distribution lying in this Nation. Hence our interest in electric Energy Systems and the Storage Research that we're discussing here today.

We believe that the U.S. Government has a key role, along with the electric utility industry, in a common goal of providing dependable, safe, efficient electric power to the people in this country. The recent NRECA annual meeting in New Orleans, which was attended by nearly 11,000 people, mostly directors and managers of rural electric systems, the NRECA membership adopted a specific resolution in support of Fuel Cell and Electric Energy Systems Research Programs and reaffirmed some earlier resolutions supporting various aspects of electric energy systems research, and I've attached those resolutions to my prepared statement.

The resolution on Research for electric power self-sufficiency and national security specifically calls for a well-funded long-range commitment both for fuel cell development and for electric energy systems research and development and urges a minimum funding of $30 million for fiscal 1986, along with adequate staffing for electric energy systems research. The resolution points out that electric energy systems research is involved with several programs of critical national importance, among them the Electromagnetic Pulse Program: and the resolution also cites examples of other projects which require strong support, including technologies for improving efficiencies and reliability of power generation, transmission, energy storage and the electric field effects of high-voltage transmission lines. We believe that a very strong Federal presence in the electric fields research is essential for objectivity and for public acceptance of these research results. And it is these kind of research programs that are in the national interest and, for the most part, can only be funded, we believe, by the Federal Government.

Yet, in spite of the obvious need for these programs we note that the administration request is only for $10 million for electric energy systems research in fiscal 1986 and that's half of, as you have pointed out, Mr. Chairman, half of the expenditures in 1985 and we note also that we now have only a skeleton staff there to manage these programs. We understand that there are now only three professional scientific persons on the electric energy systems staff, compared to 25 or so 5 years ago. And without the strong support of this committee it appears that this important research is really destined to be phased out entirely.

We feel that the Federal Government sponsored electric energy research is more important than ever now as utilities, under public and economic pressure to curtail and delay construction of new plants, are going to have to strive to operate with reduced reserve capacity. Without more sophisticated operating systems, equipment and transmission networks the Nation could be faced with greatly reduced reliability of electric service. We've come to depend on that electricity to be there when we flip the switch, but as utilities begin pushing the capacity of their systems to the limit that high degree of reliability that we've come to expect is almost certain to begin to deteriorate and I think it's for that reason that it's important that we keep the electric energy systems group in place and support its work.

The energy storage program is also faced with some drastic cuts if the President's budget is adopted, reduced from $16—from $19.6 million in 1985 to $16.1 million and the budget in 1984 was $25.7 million. This is a very important program and we believe that the thrust for advanced batteries for load leveling is just beginning to pay off. We would urge that the Department of Energy's plan to terminate support for the battery energy storage facility be reconsidered and that funds for this important work be reinstated.

Not only does the program of developing and testing new battery concepts have value for utilities, but it is a technology that is essential in order to make most renewable energies practical for power production and it can also provide stimulus to battery development for electric vehicles. Rural Electric Systems have a special interest in battery technology because for them it's an ideal way for them to manage their loads. And industries also could benefit by reducing their costs by using battery storage to take advantage of time of use rates.

In our own research program we expect to look at the possibilities of using battery technology as a means of helping dairy farmers to reduce their peak demands and their costs. At last year's hearing I reported to you that the NRECA Research Program is funding the development of an electric battery-powered farmstead tractor and the idea for that tractor actually came out of the Department of Energy Research Program, which studied the feasibility of the potential of electric vehicles in agriculture and I'm pleased to report here today that we do have that first prototype battery-powered tractor built and under test and its performance has exceeded our expectations and we're getting a lot of interest expressed by farmers and manufacturers in this development.

As a followup to that project we are currently building a second model, a 40 horsepower class tractor, which we hope to have completed by mid-summer and put under test. The point I'm making here is that battery technology is going to be important to us and we are moving along in that direction. We're trying to take advantage of the quiet nonpolluting features of the electric vehicle for farmstead use in an area where speed and range and weight are not problems. So, we're using state-of-the-art lead-acid batteries, but of course that tractor and that technology could be advanced considerably with better batteries, more advanced batteries, and better technology. So, we urge this committee to continue its support of the Energy Storage Program and also the reinstatement of the EES participation in the BEST facility.

And finally I'd like to reemphasize one point that we have made at previous hearings and that is our concern over the trend toward shifting the responsibility of major research, including high-risk, short-, and long-range projects to the private sector. There appears to be a prevalent, but I believe mistaken view, that industry is in a position to carry forth and complete these research projects that the Government chooses to abandon. EPRI, Electric Power Research Institute, I believe has shown excellent cooperation in accepting as much of the burden as possible, but great demands have been put on the entire electric utility industry and there are severe capital limitations that prevent them from carrying out some of these major research programs.

But, the needs are obvious and some of these projects, such as the sensitive issues of electromagnetic pulse, electric field effects research, we believe can only be done by the Federal Government, at least to the public satisfaction. The systems are continually asked to spend huge sums of money to improve the environment increase reliability and at the same time keep the cost of electricity as low as possible. They're trying, but I believe they, and the public, need Government support for these research efforts to help them improve efficiencies and productivity in an environmentally acceptable way.

I want to commend this committee for the support that you've given to electric energy systems and energy storage and small hydro in the past. Without this support of this committee I'm sure that we would not have accomplished the kinds of things that have been accomplished, but we would urge you now to continue to give that support and to give a message to the administration to increase the technical professional staff at EES to at least six and preferably eight people, in order that they can realistically and effectively carry on a meaningful and productive program.

Mr. Chairman, we appreciate the opportunity to present these views.

[The prepared statement of Mr. Endahl follows:]

STATEMENT OF
NATIONAL RURAL ELECTRIC COOPERATIVE ASSOCIATION
to the
ENERGY RESEARCH AND PRODUCTION SUBCOMMITTEE
HEARING ON FY86 AUTHORIZATIONS FOR
DOE ELECTRIC ENERGY SYSTEMS AND ENERGY STORAGE R&D

Washington, D.C.

March 7, 1985

Madam Chairman and members of the Committee: My name is Lowell J. Endahl, manager of Energy Research and Development for the National Rural Electric Cooperative Association (NRECA). We appreciate the opportunity to present the NRECA membership views with respect to the U.S. Department of Energy funding and activities relating to Electric Energy Systems and Energy Storage systems.

NRECA is the national service organization representing nearly 1000 non-profit, consumer-owner rural electric systems which deliver electric power to approximately 25 million people in the rural and sparsely populated agricultural areas of 46 states. These relatively small cooperatively-owned electric utilities are located in about 2,600 of the nation's 3,100 counties, and they own and operate about 44% of the miles of distribution line in the United States to serve less than 10% of the nation's population. They own only about 3% of the nation's generating capacity, and they distribute about 11% of the nation's electricity.

The research under consideration today relating to electric energy systems and energy storage systems is of particular interest and importance to rural electric systems. Indeed, research in these areas is vital to the entire nation as we work to enhance the safety, efficiency and reliability of providing electric power on a continuous and economical basis. We feel that the U.S. Government has a key role along with the electric utility industry in this common goal--a role that cannot be neglected.

At the recent NRECA annual meeting (February 4-6) in New Orleans, attended by nearly 11,000 people (mostly directors and managers of rural electric systems), the NRECA membership adopted a specific resolution in support of fuel cell and Electric Energy Systems research programs, and reaffirmed other earlier resolutions supporting various aspects of Electric Energy Systems research (resolutions attached).

The resolution on "Research for Electric Power Self-Sufficiency and National Security" specifically calls for a "well funded, long range commitment both for fuel cell development and for Electric Energy Systems (EES) research and development" and urges "minimum funding of $30-million for FY 86, along with adequate staffing for Electric Energy Systems research." The resolution points out that EES is involved with several programs of critical national importance. Among them is the study of the effects of Electro Magnetic Pulse (EMP) which, in the event of strategic military weapon explosions in the atmosphere, could disrupt communications and immobilize the entire electric generation and delivery system in this nation.

The resolution also cites examples of other EES projects which require strong support including technologies for improving efficiencies and reliability of power generation, transmission and energy storage, and the electric field effects of high voltage transmission lines. A very strong Federal presence in the electric field effects research is essential for objectivity and public acceptance of research results. These are the kinds of research programs that are in the national interest and, for the most part, can only be carried out by the Federal Government.

Yet in spite of the obvious need for stepped up programs in these areas, we note that the Administration budget request is for only $10 million for Electric Energy Systems for FY 1986--less half the $20.6 million in EES estimated expenditures in FY 1985. We are also concerned that there is now only a skeleton staff to manage these programs. We understand that there are now only three professional staff members remaining in EES compared to 25 to 30 five years ago. Without the strong support of this Committee, it appears that this important research is destined to be phased out entirely.

We feel that government-sponsored electric energy research is more important than ever as utilities, under public and economic pressure to curtail or delay construction of new plants, strive to operate with reduced reserve capacity. Without more sophisticated operating systems, equipment and transmission networks, the nation could be faced with greatly reduced reliability of electric service. We have come to expect the electric power to be there when we flip the switch. As utilities begin pushing the capacity of their systems to the limit, that high degree of reliability which we have come to expect is certain to deteriorate. It is important that we keep EES in place and continue to support its work.

The energy storage (STOR) program, which shares a common goal with EES in striving to enhance the efficiency and reliability of electric power usage and supply, will also receive drastic cuts if the President's budget is adopted. The administration budget request is for $16.1 in FY 86 million compared to $19.6 million in FY 85 and $25.7 million in FY 84. This, too, is a very important program--one which is just beginning to show results.

The thrust for advanced batteries for load leveling is just beginning to pay off. With the interest that has been generated among manufacturers and utilities, and with support from the Electric Power Research Institute, the government could easily leverage its investment and help to bring into being a new technology that would have great benefit for the public. We would urge that DOE's plan to terminate support for the Battery Energy Storage Test (BEST) facility be reconsidered and that funds for this important work be reinstated. Not only does the program of developing and testing new battery concepts have value for utilities, but it is a technology that is essential in order to make most renewable energies practical for power production, and it can provide the stimulous to battery development for electric vehicles.

Rural electric systems have a special interest in battery technology because it can be the ideal way for them to manage or level their loads. Industries could also benefit and reduce their costs by using battery storage to take advantage of time-of-use rates. In our own research program, we expect to look at the possibilities for using battery technology as a means of helping dairy farmers reduce their peak demands and their costs of power.

At last year's hearing, I reported to you that the NRECA research program is funding the development of an electric farm chore tractor in cooperation with South Dakota State University. The idea for the tractor was a direct result of a feasibility study, initiated by the Department of Energy, on the potential for electric vehicles in agriculture. Today I am pleased to report that the first prototype, battery-powered electric tractor (80 hp class) for use around the farmstead has been built and is under test. Its performance has exceeded our expectations and the interest expressed by farmers and potential manufacturers has been very encouraging.

As a follow-up project resulting from expressed interest in a smaller electric tractor for use inside farm buildings, we are building a second prototype (40 hp class) skid loader. We hope to have that vehicle ready for test by mid-summer. Both tractors capitalize on the opportunity to exploit the quiet, non-polluting features of electric vehicles on the farm where the usual requirements for speed, range and weight are not problems. We are using state-of-the-art lead acid batteries, but the potential for the tractor could be greatly enhanced by continued improvements in battery technology or by an advanced battery. We urge this Committee to continue its support of the Energy Storage (STOR) program and the reinstatement of EES participation in the BEST facility.

Finally, I would like to reemphasize a point that we have made at previous hearings. We are concerned over the trend toward shifting the responsibility for major research (including costly, high-risk, short and long range projects) to the private sector. There appears to be a prevalent, but mistaken view that industry is in a position to carry forth and complete the research and development efforts that Government abandons. The Electric Power Research Institute, which rural electric systems support, has shown excellent cooperation in accepting as much of the burden as possible, but great demands have been put on the entire electric utility industry, and severe capital limitations prevent them from carrying out an expanded research program. Yet the needs are obvious, and furthermore, some of the projects, such as those involving such sensitive issues as Electro Magnetic Pulse (EMP) and the electric field effects, can only be done to the public's satisfaction by the Federal Government.

The electric utilities are constantly called upon to spend huge sums of money to improve the environment, to increase reliability, and at the same time, keep the cost of electricity as low as possible. They are trying. But they, and the public, need Government support for research efforts that can help them improve efficiencies and productivity in an environmentally acceptable way.

The programs under consideration today are relatively small in terms of funding requirements, but we feel that they are extremely important, and most of them have suffered severe reductions in the past several years. These programs might not be in existence at all except for the excellent support that this Committee has given them. We very much appreciate the interest that this Committee has shown in the Electric Energy System and Energy Storage technologies and we ask your continued support for adequate funding. But we also urge that you give a message to the Administration to increase the technical professional staff in EES to at least six and preferably eight in order that they can realistically and effectively carry out a meaningful and productive program.

We thank you for the opportunity to express these views.

RESOLUTIONS
Adopted or Reaffirmed
at the
NRECA Annual Meeting of Members
New Orleans, LA., February 6, 1985

RESEARCH FOR ELECTRIC POWER SELF-SUFFICIENCY AND NATIONAL SECURITY

We support a well-funded, long-range commitment both for fuel cell development and for Electric Energy Systems (EES) research and development. These areas have national security implications as well as the potential for providing opportunities for energy self-sufficiency.

We therefore urge the Administration and Congress to provide the following:

1. A five year commitment for fuel cell research and development. The potential offered by fuel cell technology for highly efficient, dispersed electric power generation (so essential to national security) is enormous. Along with the potential economic advantages, the fuel cell has other very desirable characteristics--i.e., environmentally benign, and favorable load-following capabilities--which make it truly a power source worth developing and commercializing.

2. Minimum funding of $30 million for FY 86, along with adequate staffing, for Electric Energy Systems research within the Department of Energy. EES is involved with several programs of critical national importance.

    * Among them is the study of the effects of electromagnetic pulse (EMP) which, in the event of a strategic military weapon explosion in the atmosphere, could result in a pulse from gamma rays that could create an electric system surge from 10 to 100 times faster than a lightning stroke. Such a pulse could disrupt nationwide communications and immobilize the entire electric industry.

    * Other EES projects which require strong support include system technologies for improving efficiencies and reliability of power generation, transmission and energy storage, and the electric field effects of high voltage transmission lines.

PRIORITIES FOR FEDERAL ENERGY-RELATED RESEARCH

To meet America's future energy needs, we must develop every practicable energy source that shows promise of becoming feasible and environmentally acceptable through technological research and development.

Among projects that need adequate funding are: electric field effects; basic transmission and distribution systems research; superconducting technology application; systems control and analysis; and advanced electric energy (battery) storage.

Other technologies which show potential for commercialization and which deserve continued or incrased funding and support by the Federal Government including the following:

- Fuel cell research and development;
- Gas Cooled and fast-breeder reactors;
- Geothermal;
- Peat, lignite and coal technologies (including gasification, liquefaction, fluidized bed combustion and MHD);
- Energy management and storage technologies (including compressed air, underground pumped hydro and battery storage);
- Solar energy systems (including residential heating and cooling, solar thermal, and photovoltaic generation of power); and
- More efficient small- and medium-scale power generation systems which can utilize coal and/or waste products and which can be used in a cogeneration mode.

We urge that in development and demonstration of each of these technologies, special recognition and attention be given to their impact on, and compatibility with, electric utility systems. We further urge the Federal Government to coordinate these research efforts with EPRI.

EXTRA HIGH VOLTAGE TRANSMISSION LINE RESEARCH

The increased use of extra high voltage (EHV) overhead transmission lines for transmitting electric power by rural electric cooperatives is essential if we are to continue to meet the electric power needs of rural America. Recent experiences in acquiring right of way and constructing such EHV lines have revealed serious misconceptions, mystique and fearfulness on the part of the general public as to the electric field effects on vegetation, animals and even people living in close proximity to such EHV lines.

Although such concerns are not supported by scientific evidence, we have an urgent need to provide positive, scientifically demonstrated evidence that there are no significantly adverse effects upon vegetation, animals and people living in close proximity to such EHV lines. NRECA urges the Congress and the appropriate Federal agency to adequately fund electric fields research work involving both alternating and direct current overhead EHV lines and disseminate such information to the public.

ENERGY EFFICIENCY TECHNOLOGY

Conservation, by efficient production and use of energy, will play an important role in the present and future national energy strategy. Rural electric systems pledge their continued efforts to assist their member consumers in the wise and efficient use of electric power.

To maximize the potential for efficiency in electric energy production and use, however, considerably more effort on research, development and demonstration of new energy-efficient technology is urgently needed. This includes expanded research on load management techniques and equipment, and on the technology, economics and impact of integrating new sources of energy into existing utility networks.

In addition, work to further improve efficiencies in electric power distribution is needed. Distribution losses alone result in significant loss of peak load capacity of annual energy production. The annual value of such losses for the industry could be appreciably reduced with improvements in transformer loss characteristics, power and load factors, and other design and operating parameters.

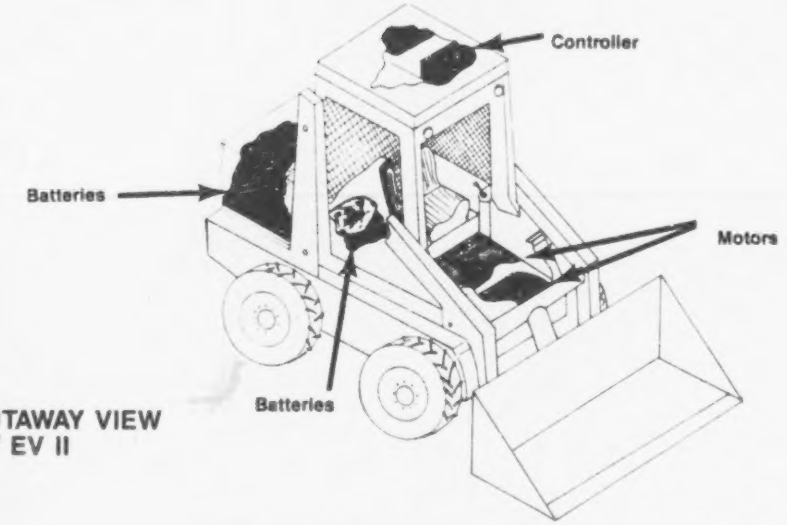
We believe that further research can make such improvements economically feasible and we strongly urge the Administration and Congress to fully support an expanded long range program of transmission and distribution loss reduction research; and on such other technologies that might beneficially impact on the electric distribution system.

Electric Choremaster - I

This tractor is designed for farm chore use, particularly for feedlot conditions. South Dakota State University designed and built this vehicle with support from the NRECA Research Fund. Utility uses include backhoe and trenching work and moving equipment around in pole yards.

Features

- 100 HP break-away power - 50 HP continuous duty.
- 4000 lb battery provide 4-8 hours of operation (about 15 miles of chore routines).
- Operates like a hydrostatic - variable speed shift.
- Quiet, less vibration and safe for use in buildings.
- Outlives conventional diesel tractors and is more reliable.
- 10-15% higher initial cost but life-cycle cost savings compared to diesel.
- Ideal for off-peak charging.
- New application of electric energy to agriculture.
- Perfect for stop-and-go driving conditions.
- Starts with a flip of a switch.



CUTAWAY VIEW
OF EV II

Electric Choremaster - II

This tractor is designed for farm chore and industrial applications where maneuverability and compact size are critical. South Dakota State University is designing and building this vehicle with support from the NRECA Research Fund. Utility uses include materials handling in buildings and around yards and operation of scrapers, etc.

Features

- 50 HP break-away power - 25 HP continuous duty.
- 1800 lb battery provide 3-6 hours of operation.
- Operates like a hydrostatic skid steer - shift-on-the-go with sharp turning capabilities.
- Quiet, less vibration and safe for use in buildings.
- Outlives conventional diesel tractors and is more reliable.
- 10-15% higher initial cost but life-cycle cost savings compared to diesel.
- Ideal for off-peak charging.
- New application of electric energy to agriculture.
- Perfect for stop-and-go driving conditions.
- Starts with a flip of a switch.

Mr. VALENTINE. Thank you very much, Mr. Endahl.

Dr. Mannella.

STATEMENT OF DR. GENE G. MANNELLA, DEPUTY DIRECTOR, WASHINGTON OFFICE, ELECTRIC POWER RESEARCH INSTITUTE

Dr. MANNELLA. Thank you, Mr. Chairman, I would like to have the full text of my statement entered into the record and I would also like to endorse the comments of my colleagues here on the panel. Many of the points that they have made I make also in my statement and I'll try not to repeat them as I give a summary now of my remarks.

My name is Gene Mannella and I'm with the Electric Power Research Institute. I have with me today Mr. Joseph Porter from our Electric Systems Division, who will help me answer some technical questions if the need arises.

EPRI, as I'm sure you know, is an organization that was started by the electric utility industry about 12 years ago to implement and manage a program on the generation, transmission, distribution, utilization of electric power. EPRI has about 525 utilities which are members, and that includes investor owned, publicly owned, as well as the cooperatively owned utilities, and these members represent about 70 percent of the generating capacity in the United States. We have an annual budget of about $300 million per year. I'd like to make a comment at this point in time relative to some of the points that were made by the DOE witnesses, EPRI's budget has been basically flat for the last couple of years. The dues or the contributions which our members make to us are keyed to the kilowatt-hour sales of electricity in the United States in the main and you may recall that in 1982, for the first time in most of our memories, kilowatt-hour sales actually fell, primarily because of the economic slowdown that the country saw at that time. So, we have not been able to increase our budget in any significant way over the past several years and that's a point which I may bear on later in my comments.

My statement today, I think, is somewhat of an interesting combination of themes. That is, very strong cooperation, respect, and admiration for our colleagues in the Electric Energy Systems and Storage Programs at DOE, as well as a certain amount of chastisement of the Department for not looking after them in a little better fashion. We do have a very strong cooperation with the group. Again in my statement I point out this has not always been the case, that as these energy programs were perceived to be of higher priority some years ago and both these groups had budgets of about $40 million per year there was a great tendency for cooperative programs. We and many other people joined in cooperative programs with the Department. There was then a shift in the philosophy of the Federal role and we had to adjust accordingly. And again, I must say, relative to the comment made earlier this morning questions are being asked about whether the private sector would pick up these programs. There seemed to me an overtone in that conversation that the private sector had not done this, when indeed we have spent most of the last several years doing just exactly that as the budget level for these programs has decreased.

I mention just with regard to the storage program and on page 2 of my testimony that EPRI, for example, has taken over the responsibility for the underground pumped hydro and compressed air energy storage work that was originally started by DOE. We've done the same for the hydrogen generator, based on technology that was earlier developed by DOE. We are very committed to support a test of a 2 megawatt zinc-chloride battery, which is based on the technology that was developed by DOE and we have committed to the procurement of sodium-sulfur and zinc-bromide batteries for evaluation. We have effectively interleaved our program with that of DOE, adapting to their approach of the long-term, high-risk, high-payoff, and on our shorter term, more immediate application-type of program.

We think it's extremely important, it's critically important to us that the Department be able to support their obligations in these areas, for example, in zinc-bromide and sodium-sulfur, at about $7 million in 1986.

A comment has been made this morning about the BEST facility and again I touch on this in my statement I feel very strongly about that facility. EPRI has represented any number of times that the BEST facility is not a demonstration. The BEST facility is an integral part of battery R&D. You cannot develop a battery if you cannot test it in an environment in which it's going to be used. That's true for any technical system. You have to test it in an environment which approximates where it will be used. We, and the utility involved, entered into the development and the utilization of the BEST facility as a national testbed for batteries, with a commitment on the part of the Government that they would fund 50 percent of the operation of that facility. Unfortunately in 1984 DOE had no funds or made no funds available for the BEST facility. In 1985 they are funding it at a rate of about 30 or 40 percent and we are very distressed to see that in the budget request for 1986 they requested zero dollars. To us that's just an abrogation of an agreement between the Federal Government and the private sector, which was made in good faith and which the private sector has supported without qualm or hesitation. We urge this committee very much to suggest a funding level of about $1.5 million for DOE to remain in the BEST facility.

With regard to the overall EES Program, like previous witnesses, we're very distressed at what we see being requested here, a 50-percent reduction in funds. This is not the first reduction. The program was at about $40 million several years ago. We're really kind of confused as to what the rationale for this reduction is, because again, as has been touched upon by previous witnesses, the work that the EES group is doing is completely suitable and in some cases only can be done by the Federal Government. I just can't think of anybody else who could do work on EMP with any meaningful results or activities, so we don't see it as a question of, you know, an improper Federal role. The program has been scrubbed down to the level where that which remains is certainly in the best interest of the Government and doable only by the Federal Government. We would suggest that the work that they're doing in the biological effects of alternating current field, direct current fields, direct current ions, and the electromagnetic pulse work, the DC transmission work, as well as the cable work, should be continued and that we would recommend for fiscal year 1986 funding for both EES and storage an amount equal to that which was appropriated in 1985. Finally, one other point which I do touch upon in my testimony and which is also of concern to us, is the uncertain organizational status of both of these programs. Mr. Endahl very adequately addressed the deplorable situation with regard to staff, that the staff levels have drifted down from 25 professional to 3 in the case of EES and 4 in the case of storage and how these programs have been in a state of transition from one part of the organization to another. I must confess I was a little bit distressed this morning to hear the Under Secretary say that it would take another 60 days to complete this, which has been underway for 8 months. Mr. Chairman, I have seen new agencies created in this town ab initio in less time than that. And we would just simply urge the members of this committee to convey to the Department the need for organizational stability, as well as suitable head count to conduct these nationally critical programs.

This completes my statement, I'd be happy to answer any questions you might have.

[The prepared statement of Dr. Mannella follows:]

STATEMENT OF GENE G. MANNELLA
DEPUTY DIRECTOR, WASHINGTON OFFICE
ELECTRIC POWER RESEARCH INSTITUTE

TO THE

ENERGY RESEARCH AND PRODUCTION SUBCOMMITTEE
OF THE HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY
OVERSIGHT HEARING ON
THE U.S. DEPARTMENT OF ENERGY PROGRAMS
IN ELECTRIC ENERGY SYSTEMS AND ENERGY STORAGE

MARCH 7, 1985

Madame Chairman and members of the subcommittee. My name is Gene G. Mannella and I am Deputy Director of the Washington Office of the Electric Power Research Institute (EPRI). On behalf of my organization I would like to thank the subcommittee for the invitation to appear here today to discuss Federal research programs in electric energy systems (EES) and energy storage (STOR), with emphasis on their relationship to activities ongoing in the private sector.

Accompanying me is Mr. Joseph Porter of EPRI's Electric Systems Division who will be happy to answer technical questions on EPRI's electric systems research and development program.

EPRI is an R&D planning and program management organization set up by the electric utility industry in 1973. Our mission is to implement a comprehensive research, development and demonstration program in electric power generation, transmission, distribution and utilization for the benefit of our member utilities and their ratepayers. Currently 525 utilities representing 70% of the generating capacity in the United States are members of EPRI. In 1985, we will expend in excess of $300 M in the pursuit of a program of R, D and D to achieve environmentally acceptable, economically attractive, highly reliable supplies of electric power for the nation's economic well-being.

In pursuing this program EPRI will emphasize the near- and immediate-term approaches to technological advancement. This is particularly important in understanding the excellent cooperative arrangements that have developed with the Department of Energy (DOE) in recent years. EPRI programs, formulated in response to industry needs through our extensive advisory structure, are primarily targeted to produce results in the next ten years while long-term research (i.e., payoff beyond 20 years) comprises less than 5% of our program. This complements the DOE program with its long-term, more basic focus.

The path of such successful cooperation, however, has not been easy. The members of the Science and Technology Committee are well aware that in the crisis atmosphere of the 1970's the Federal Government embarked on an ambitious energy R&D campaign in which cooperative ventures and cost-sharing with industry were strongly encouraged. The private sector responded vigorously and many jointly-funded activities were undertaken. (One of these, for example, is the Battery Energy Storage Test (BEST) Facility which is operated by Public Service Electric and GAS (PSEG). I mention this specific activity because I will return to it later in this testimony, as an example of where the Federal Government should live up to agreements made in good faith in a time of national need.)

As the perception of crisis passed, the Federal Government re-trenched, changed its program philosophy and cut back sharply on many programs, especially those involving demonstrations. This caused major dislocations in the pursuit of many research programs and has led to the widely-held belief which you, Madame Chairman, enunciated in your speech at EPRI's 10th anniversary in 1983 when you noted that the Federal Government had become a poor partner in cooperative R&D programs. Nevertheless, after a period of adjustment of both EPRI and DOE programs occasioned by declining DOE appropriations, both organizations have worked very effectively to integrate their programs and achieve a high level of cooperation.

The result is a highly integrated--yet separate--research and development program wherein EPRI commits its funds to the demonstration and commercialization of technologies initially funded in their conceptual period by DOE. Each side thus is able to leverage its funding to achieve both increased results and improved opportunity for commercialization while still being responsive to its individual charter and mission. I submit that this is a truly noteworthy example of federal/private sector cooperation, which should be encouraged and not allowed to deteriorate.

Turning now to the specifics of the storage program, since the shift in Federal program direction EPRI has adjusted its program along the following lines:

- EPRI assumed responsibility for underground-pumped hydro and compressed air energy storage hardware/field test projects initiated by DOE.
- EPRI is demonstrating prototype hydrogen generators based upon technology that was earlier supported by DOE.
- EPRI is about to support the test of a 2MW zinc chloride battery that uses technology confirmed through the test of a 100kW demonstration module under joint DOE/EPRI sponsorship.
- EPRI will procure developmental sodium-sulfur and zinc bromide batteries for evaluation at the BEST Facility; the technology for these batteries will be developed under DOE funds.

Battery R&D continues to be a high priority activity at EPRI due to the important role that batteries can play in load leveling and vehicular applications. Advanced batteries are approaching the stage where developmental systems can be fabricated and evaluated in a utility environment. EPRI is presently procuring a prototype zinc chloride system for evaluation and has two coordinated projects with DOE to procure and test zinc bromide and sodium sulfur batteries after DOE has completed the technology development. It will therefore be important for DOE to be able to support their obligations to both zinc bromide and sodium sulfur battery R&D at $7 million in FY86. EPRI's FY86 budget for advanced batteries is about $5 million. Individual electric utilities will expend a similar amount to procure and test early prototype systems. Furthermore, since DOE is the only significant sponsor of long-term, technology base research in electrochemical systems these efforts should be maintained without reduction from the FY85 level.

DOE's thermal and mechanical energy storage efforts have already yielded results that have found their way into the private sector. High head pump turbines, compressed air energy storage designs, and prototype hydrogen generators have benefitted from prior years' efforts. Thermal energy storage research, especially on advanced materials and concepts useful for diurnal storage, can be important to the private sector efforts focusing on cost-effective use of both cool and heat storage for residential and commercial application. Support in the range of $3-4 million/year would be commensurate with EPRI and other private sector activity in this area. We have also recently established with DOE a low-level coordinated research effort on superconductive magnetic energy storage. This extremely efficient (>90%) technology will be cost effective if significant improvement can be made in the current carrying capability or the costs of the superconductors. In less than 18 months our efforts have already yielded a five-fold improvement. We strongly urge that this be continued at about $0.5 million/year.

I would like to return to an earlier item, namely the BEST facility, which is fundamental to the battery R&D program. After a hiatus of one year, in 1985 DOE restored funds to allow partial support of the Battery Energy Storage Test Facility. This highly successful example of our collaborative efforts is presently the site of the first proof-of-concept zinc chloride battery system. This Facility will continue to be the National focus necessary to expedite the transition from laboratory to hardware verification. DOE had co-shared equally the costs of this Facility through FY83 prior to the hiatus in 1984. In FY85, they will fund at the 30-40% level with EPRI funding the balance. We would hope to see DOE return to its full partnership status in FY86 and fund at the level of $1.5 million. We are distressed that the DOE budget documents appear to suggest that once again the department intends to back out of an agreement made in good faith by EPRI and the utility involved.

With regard to the DOE EES program, examination of the department's budget submission gives rise to two concerns of major proportions. First is the proposed budget level of $10M for EES. The budget documents available do not give any rationale or reason as to why a decrease of over 50% from FY85 appropriations is sought. Given the history of funding for this program, it is difficult not to conclude that the figure of $10M is an arbitrary level, reducing activity in this program from its recent high of $40M per year to only 25% of that total. Many of us are distressed in reviewing the program description that accompanies this request to learn that under the proposed funding the following would occur:

- stretch-out of research on biological effects of a.c. carriers
- stretch-out of research on biological effects of d.c. systems
- reducing the level of effort of the effect of electromagnetic pulses (EMP) on the national electrical supply system
- discontinuation of research on failure mechanisms associated with the electrical supply system
- as mentioned above, termination of support for BEST
- virtual cessation of productive work on high voltage d.c., materials, superconducting technology advanced battery applications and the Hawaii Deep Water Cable program.

The latter items would be funded in FY86 for documentation only, which is viewed as a prelude for a further 50% budget reduction or complete phase-out in FY87.

The importance of transmission in the national electrical energy picture has come to the forefront over this past year. Within the Department of Energy, all transmission-related problems come within the scope of the Electric Energy Systems Division. There is a stark contrast between the increasing perception of the importance of transmission and the proposed sharp reduction in the funding of DOE's Electric Energy Systems program.

The work that DOE has been carrying out on the effects of electrostatic fields and electromagnetic fields is truly a proper function of government research. Since they have no vested interest in the results, the credibility of answers obtained in such studies is unchallenged. Also, in areas such as evaluation of the impact of electromagnetic pulses (EMP) on power systems, a government agency such as DOE has ready access to classified information that might be more difficult to obtain the private arena. Moreover, a phenomenon such as EMP is so closely interrelated to our long-term nuclear defense policies that it would appear to be the responsibility of the government to carry out such studies.

There are several other areas in which research has been ongoing in the Electric Energy Systems Division that must also be addressed. For example, they have been in the forefront of the development of information on d.c. transmission. This is an extremely important tool in any future modification or expansion of the existing transmission networks within the United States.

Similarly, reliability studies related to both normal and emergency conditions are a matter of national concern. While these areas are being researched by the private sector, and the studies carried out by EES are necessary and complementary parts of the overall picture. Basic research on new materials, with possible enormous impact on future power systems, would seem to be a natural area of endeavor in government sponsored research work.

Finally, some specific projects related to underground transmission should be cited as requiring continued support. Two projects in particular, which are well along, are the Hawaiian deep water cable for tying the Hawaiian Islands together electrically, and the Brookhaven National Laboratory's work on synthetic taped cable. This latter work, which is a spinoff of earlier superconducting cable work carried out at Brookhaven, shows promise of providing a distinct leap forward in the capability of underground transmission lines. If successful, it would greatly reduce the differential in cost between underground and overhead transmission.

It is difficult to conceive of a rationale for this budget proposal. The private sector has continued its efforts in those areas where the industry will benefit in the short and intermediate term with the understanding that DOE would undertake the longer-term more fundamental programs. The research areas involved--field effects of high voltage transmission, protecting the integrity of the electrical transmission system and research on cable technology, batteries, and superconductivity--are all appropriate for the DOE and fit the Federal role as we understand it. EPRI supports the efforts of the Administration and the Congress to reduce the deficit and we do not suggest increases in these budgets to the levels of previous appropriations. We do, however, strongly urge that FY86 funding in an amount at least equal to FY85 be provided by judicious reapportionment within the overall DOE budget.

The second area of concern with regard to the EES and also the STOR program is the proposed re-assignment from the Conservation to the Renewables office. The organizational history of these programs from their position in the AEC and Department of Interior, transfer to ERDA and then to the Department of Energy, has been one of buildup and then severe reduction. Accompanying the funding reduction has been staff attrition both from reductions in ceiling as well as departures and resignations brought on by the waning fortunes of the program. These program have suffered long and severely from changes in program direction and philosophy, organizational instability and consequent low morale. Their position at present is unclear--they have presumably been designated to leave Conservation but have not yet been transferred to Renewables. It is also not clear whether they will ultimately be located as individual offices or divisions, combined into a single group or dispersed throughout an existing structure. One clear result of this confusion is that they were essentially orphaned during the development of the FY86 budget request, which may be the reason why EES is scheduled to suffer a 50% reduction that bears no relationship to the national importance of its programs. It would be an exemplary move by the new management of DOE to lift the uncertainty from the staffs of the STOR and EES program offices, as well as, those of us in the private sector that have committed our resources to jointly developed R, D and D programs so that these nationally important programs can move forward expeditiously.

Madame Chairman, members of the subcommittee, it has been a pleasure, as always, to appear before you. The Science and Technology Committee has a long and distinguished history of support and sponsorship of energy R&D programs. We hope that our testimony this year will help your decision-making with regard to the STOR and EES programs. This concludes my testimony. I would be pleased to answer any questions you might have at this time.

EPRI
Electric Power
Research Institute

GENE G. MANNELLA

Dr. Gene G. Mannella is Deputy Director of the Washington office of the Electric Power Research Institute (EPRI).

Prior to joining EPRI in 1983, Dr. Mannella was Vice President and General Manager of the Stirling Division of Mechanical Technology, Inc., a high technology R & D manufacturing concern. Dr. Mannella was Senior Vice President of the Institute of Gas Technology from 1977 to 1979. Prior to that, he held a series of government positions in ERDA, DOT, and NASA, where he was responsible for Federal programs in energy conservation, vehicle safety, and aerospace technology, respectively.

He has authored numerous technical papers, served as chairman of two International Conferences on Experimental Safety Vehicles under NATO/CCMS sponsorship, and was head of the U.S. Section on Automotive Transport of the Joint U.S..-U.S.S.R. Technical Exchange on Transportation.

Dr. Mannella is a recipient of the NASA Apollo Achievement Award, the DOT Award and medal for Meritous Achievement, and the ERDA Award for Outstanding Leadership.

He received a B.S. in Chemical Engineering (with honors) from Case Institute of Technology in 1953 and a Ph.D.in the same field from Rensselaer Polytechnic Institute in 1956.

June 1984

Mr. VALENTINE. Thank you very much.

I have just two or three short questions and then we'll yield to the other members who are here.

Dr. Lawrence.

Dr. LAWRENCE. Yes, sir.

Mr. VALENTINE. What do you consider to be really a minimum budget level for Electric Energy Systems and Electric Storage Programs which would allow an acceptable level of research effort, bearing in mind the horrendous deficit problem that we have and that everybody would like to have more and I've found that you can build a pretty dog-goned good case for whatever it is that you are involved with being the most important thing going on in the country, but the fact is, I think, that with the present political situation in this country and the mandate which the President either received or perceives that he received there are going to be some reductions, whether we like them or not and so excepting that, would you be in a position—maybe you'd prefer not to do this, I don't know. I'd like to have a little better definition from you as to what you think would be fairly adequate.

Dr. LAWRENCE. I appreciate what you're saying, Mr. Chairman. Certainly the mood in Washington is one of trying to save money rather than spending additional funds, but then by the same token when there is substantial investment already put in and where we can see a rather near term benefit from some of the previous research I would strongly recommend that increased funding be given. Now, as to the exact amount, all I can say is, Mr. Chairman, currently what's being requested by the administration is inadequate. It will curtail the programs. It will cause any amount of difficulties in certain areas. For example in electric fields, what benefit does it do when the State of New York court orders $5 million to be set aside, taken from electric utilities so that an independent study can be made of electric fields. This is exactly the kind of thing that should be avoided. There should be a central agency approach to solving a problem that involves all of our 50 States and six territories, rather than having States go off on their own, and then unfortunately not having the funding to conclude the research. I wish I could really give you a definitive figure, Mr. Chairman, but all I can tell you is that additional funds are needed. I do know without any doubt that at the suggested levels much harm will be done in the research contemplated. In fact in certain areas, honestly what will happen is that no new work will be done and the existing research level will not continue, but the existing research will be stretched out so there's going to be really a reduction in research effort. Lengthening contracts and not getting the work done and it's really a means of juggling things on paper and certainly it will not result in the research effort being continued at the same level, the way we have been lead to believe by earlier testimony.

Mr. VALENTINE. As to efforts by State legislatures, which you referred to on page 3 and which you mentioned again there, Doctor, if research results are unknown what basis do the various legislatures, the legislature in New York, what do they use to set standards?

Dr. LAWRENCE. This is just the point, Mr. Chairman. Their particular standards will be—how else can I say but they'll be conceived in good intention and bracketed so widely to be on the basis of suffering from the lack of knowledge and not be very useful. One can make up standards, one can make up regulations, one can make up legislation based on very, very little knowledge and not be very effective in it. I don't think it will stop any standards from being made, I just think the standards will be pretty bad.

Mr. VALENTINE. Mr. Mannella, in your testimony you mention problems encountered by the EPRI, you call it the EPRI, and other groups when Government commitments are not fulfilled. Can you give an example of a joint DOE/EPRI project or projects where the Government withdrew financial support before the project was completed and what happened?

Dr. MANNELLA. Well, the best one and I think the one that's perhaps the most germane to our discussion here I've already touched on, which is the BEST facility.

Mr. VALENTINE. The BEST——

Dr. MANNELLA. The BEST, Battery Energy Systems Test facility, which is located up in New Jersey. We, and the Department of Energy have a very highly coordinated program where they fund the development of certain battery types or battery electrochemistry in the early stages and as that work proves successful and moves on and one must think about acquiring very large batteries, perhaps in the 100 kilowatt category, that we would procure them and they would be tested on a utility grid in the BEST facility up in New Jersey.

Mr. VALENTINE. In the field or on the question of storage energy, storage batteries, isn't that an area that will, under normal circumstances, retract—attract substantial interest and investment from the private sector because I should think that whoever gets to this pot at the end of the rainbow first will be like the guy who invented the little cap that you put on Coke bottles and so on, there's a pile of money there. Would the—isn't that the sort of thing that is of sufficient interest, well particularly to the—you mentioned about the farm vehicles and so on? Wouldn't that be something that would be of sufficient interest to the large North American implement dealers for them to have programs of research and development that would really be much larger than the Government's?

Dr. MANNELLA. Well, speaking to the battery part of that, if I may, the market for batteries in the United States today is not really for peak shaving or peaking. It's for vehicle starting and things of that sort, and the private sector, certainly as far as the utilities are concerned is interested in this and this is why EPRI has an aggressive program. In terms of the manufacturer and supplier companies, many of them are engaging in research and development on batteries and many of them have engaged in research and development on batteries, however, more of them have gone out of business than not because of the long-term nature of the payoff for this particular application. Yet, when somebody does develop an economically attractive and functional peak shaving battery there may well be good economic payoff for them, but it's a long and very expensive process.

Mr. **Valentine**. In addition to this testimony, which is, I think, excellent, have you gentlemen and your colleagues petitioned the gentleman who heads the executive branch of the Government? You don't have to answer that.

Dr. **Mannella**. Petitioned for what?

Mr. **Valentine**. Begged him for—told—said to him what you have said to us. I'm sure that you have and if you haven't that you will. Mr. Morrison.

Mr. **Morrison**. I don't know how to follow that, Mr. Chairman.

Mr. **Valentine**. Well, I just wanted to be sure everything was covered.

Mr. **Morrison**. That's fair.

Dr. Lawrence, I have tremendous respect for the professional team you represent here this morning. You alluded to it in your testimony, but perhaps you can add to this, are we making any progress on the transmission network, making it more cost effective? It appears to many of us that we're going to be generating energy in probably fewer places in the United States and wanting to have it somewhere else. What progress are we making in that arena?

Dr. **Lawrence**. I think there's very decided progress in moving ahead, but here again let me point out one thing, that manufacturers in the private sector are not really those that develop systems, you see, and here we're talking about something that only I think really an entity such as the Department of Energy can have a very definite beneficial effect on and emphasis in moving the research ahead. Any given manufacturer, no matter who it is, some of the very famous names we know, are not really in the systems producing business. They make components and then the various utilities, of course, have their own systems, but the overall approach on a massive systems basis, has to be from an unbiased central type agency, such as the Federal Government.

Mr. **Morrison**. Do you know if there's any work that's been done by some of the people who need these systems, such as the Tennessee Valley Authority or Bonneville Power Administration, have they ever contributed to this type of basic research?

Dr. **Lawrence**. Well, they certainly have and work is going on like this at all times, but as I said it can't be done on a segmented basis, but it has to be done on an overall systems basis.

Mr. **Morrison**. Is there any chance for international cooperation since this is not our problem alone?

Mr. **Lawrence**. Oh yes, there are international agencies and dialog goes on continuously. In fact our Institute has many members outside this country.

Mr. **Morrison**. Well, Mr. Chairman, I think it's pretty easy this morning to isolate the problem. These gentlemen who are on the firing line say the programs they have described are the levels of research that logically are done by all of us collectively and Mr. Stockman and others are saying, "we're not going to pay for it," and the squeeze is pretty obvious.

Mr. Endahl, I live in a rural area. I have thousands of hours on a tractor in my former incarnation. I notice you're working basically so far with the chore-type tractor, that is one that stays close to the facilities and that's because of the limited capacity of the battery systems we have?

Mr. ENDAHL. Yes, that's correct.

Mr. MORRISON. Is anyone attempting to combine solar panels, for instance, with a battery system for extended use?

Mr. ENDAHL. Well, we anticipate that this tractor, since it's being used for chores only in the morning and the evening, could be stored under a shed with photovoltaic collectors above that shed and could recharge those batteries to some extent, but you would also have an interconnection with the system so that on those cloudy days you would still have your electric power available to you. We see potential there also as a standby power unit that could power a dairy operation for an hour or two if you needed to. There are many things we could do with that kind of a vehicle and we believe that the electric farm chore vehicle makes a whole lot more sense than the automobile at this early stage. And we think that this is a good first step, you see, and then we'll get some experience with the operation of these vehicles and ultimately we can use this then for electric vehicles for transportation purposes.

Mr. MORRISON. Because of weight and size?

Mr. ENDAHL. Yes, weight is a real problem, but not with a tractor, as you know.

Mr. MORRISON. I would sense, Mr. Chairman, that it would be possible to get support for this kind of tractor research from Congress because it's pretty clear these rigs would not make it to Washington, DC.

Mr. VALENTINE. Very good, Sid. And I want to say before I forget it that I never—I figured you for a city slicker. You don't look like a tractor driver to me.

Mr. MORRISON. Mr. Mannella, just one, maybe not even a question. EPRI is, to those who skate around outside of some of the inner-circles of the energy world have gained a great respect for the work that you're doing. Now, I find in listening to you however, that you're almost the Rodney Dangerfield of your—you're not getting any respect from those that have signed contracts and made agreements with you. Is there a complete lack of coordination between the Department of Energy on through the budgeting process with those of you in the private sector that they keep unloading things on?

Dr. MANNELLA. The answer is no, there is not a complete lack. We have continual and generally very productive discussions and interactions with program people in the Department. We meet with them very frequently. They invite us to their program reviews. We invite them to our program reviews and that's really superb. We meet with the management of the Department periodically. We have a memorandum of understanding, which calls for our management and the management of DOE to get together at least once a year to see whether we have any major problems or dislocations or what have you. To the extent that I signified any lack of respect I think it has to do primarily with the budget process and the nature of the budget process and the fact that the budget, as you know, is legally not discussable until it is presented by the President, at which point it's fait accompli and then we learn, at that point in time that perhaps we're to play a bigger role than we had ever been led to believe and we have no recourse but to come before you gentlemen and say that's not necessarily the case.

Mr. **Morrison**. Okay, well, your message has been well and appropriately delivered and I certainly would be inclined to agree that somewhere there is a magic line between what we do collectively as a society in these areas and what we leave to the profit side of the picture and it's not been appropriately drawn of late.

Dr. **Mannella**. Well, I think we can all work on it and hopefully we can get it resolved.

Mr. **Morrison**. Thank you.

Thank you, Mr. Chairman.

Mr. **Valentine**. Thank you, Mr. Morrison. Let me just mention one other thing. One—what I want to say is not altogether in jest, really, I have decided here and based on my brief experience in Congress that what you gentlemen maybe need to do is to redefine these efforts, particularly with respect to the storage of energy into a system that you call, you know, everything has to have a bureaucratic name, we'll call this SEA weapons system, the S-E-A, stands for Storage Energy Adapter. A-1, unmounted and you go to the Pentagon and tell them—and put it in the Defense budget and you'll get everything you want. I say not altogether in jest. I was—what lead me to that bit of frivolity was this thought: Is there research going on connected with the defense of this Nation in this same area? I should think that the development of a storage battery that would mean that we could move military defense weapons on fields without the necessity to haul in petroleum products and so on would be a tremendous advantage. Is anything going on in the Defense Department that is either overlaps what you do or is a part of it or—

Dr. **Mannella**. I'm not aware of any. I have had some occasion in the past few years to be involved in some of the DOD vehicular applications and they are looking at new heat engines as a replacement for the, you know, the diesel and the internal combustion engines. They are looking at turbines, but I'm not aware of any significant electro chemical system activity.

Mr. **Endahl**. There is some work in fuel cells, a small scale.

Mr. **Valentine**. Sid, there's a vote on the Floor to approve the Journal, do you have anything else you want to ask these gentlemen?

Mr. **Morrison**. No, I had every opportunity, thank you.

Mr. **Valentine**. Well, that's—thank you gentlemen very, very much and we're going to suspend this operation now so we can go over and perform a duty which if it isn't done the Nation will not move forward another day. We've got to vote on approval of the Journal. We'll be back in a few minutes then. The next panel will be Dr. Elton Cairns, from the Lawrence Berkeley Laboratory and Mr. Roger Carlsmith and we'll see you gentlemen when we get back. We'll be at ease for a few minutes.

[Recess taken.]

Mr. **Valentine**. Mr. Morrison of course, is not back yet, but I think we'll go ahead. I don't see a problem with that. Are you gentlemen ready?

Dr. **Cairns**. Yes, sir.

Mr. VALENTINE. All right. Proceed, the material which you filed with us will appear in the record and you may feel free to summarize or read it or proceed in any other way you deem appropriate. We're glad to have you here.

STATEMENT OF DR. ELTON J. CAIRNS, ASSOCIATE DIRECTOR, LAWRENCE BERKELEY LABORATORY AND PROFESSOR OF CHEMICAL ENGINEERING, UNIVERSITY OF CALIFORNIA, BERKELEY, CA

Dr. CAIRNS. Thank you, Mr. Chairman. I am providing a longer version of my testimony for the printed record and I have a shorter version which I will present now.

Good morning, Mr. Chairman and members of the subcommittee. I am Elton Cairns, Associate Director of Lawrence Berkeley Laboratory and Professor of Chemical Engineering at the University of California, Berkeley. Thank you very much for the opportunity to present my views on the very important topic of energy storage.

The U.S. Department of Energy and its predecessor agencies have supported an energy storage R&D program since the late 1960's. The aim of this program is to provide advanced energy storage and conversion systems that will shift a significant portion of our energy demand away from petroleum and toward the more available domestic fuels, such as coal, nuclear and renewable energy resources, as well as to provide efficiency improvements for energy-intensive processes. These objectives would be achieved with an environmental impact significantly more benign than that of our current practice. Energy storage systems have the important ability to decouple the variations of energy supply from those of energy demand. This feature offers a greater choice of energy sources. For example, electrical energy storage in high-performance batteries makes possible the use of electric vehicles, thereby shifting a portion of our transportation energy demand away from petroleum and toward coal, nuclear and hydroelectric energy. Energy storage in electric utility systems provides for operation of expensive power plants at a steady high power, charging the storage system during off-peak periods. During peak demand, the energy storage system provides part of the power, avoiding investment in power plants sized to meet the peak demand.

The potential economic, strategic and environmental benefits for the country that can result from the development of advanced energy storage and conversion devices are massive.

Substitution of domestic energy resources for imported petroleum will improve the U.S. financial and strategic position. For example, the use of battery powered electric vehicles could result in the reduction of petroleum imports by over 400 million barrels per year. This oil import costs $12 billion per year at present prices. Avoidance of this import would be a significant improvement in the balance of payments and less reliance could be placed on petroleum exporting countries.

Capture of the future national and international market for energy storage systems will improve the competitive commercial position of the U.S. A new multi-billion dollar per year energy storage industry would arise, providing significant stimulation of the U.S. economy.

Because emissions from energy storage devices are nil, the emission control problem is shifted to central power plants, where it it much more readily handled.

Advanced energy storage systems could help the Department of Defense achieve its energy requirements with less dependence on civilian sources, strategic reserves and foreign suppliers.

The existing DOE energy storage program has focused upon the following end-use sectors: Advanced batteries for electric vehicles, energy storage for electric utilities by means of thermal energy storage, batteries and superconducting magnetic energy storage, thermal energy storage systems for use in buildings and industry.

This program bridges the gap between fundamental research, usually performed at universities, providing the very important function of educating the researchers badly needed in the field and product development, performed by industry. The most promising energy storage systems undergo applied research, exploratory development and testing, followed by technology transfer to the private sector.

Some of the most promising electrochemical systems from the viewpoint of performance, durability, and potential cost represent significant achievements of the DOE program. The sodium sulfur battery is a high-performance, high-temperature system that uses abundant low-cost active materials. The cost and life of the ceramic electrolyte must be improved to meet the demands of both stationary and mobile applications. Recent laboratory tests have shown that novel transformation-toughened ceramic electrolyte exhibits greater resistance to cracking than the present ceramic electrolyte. If borne out in cell tests, this discovery could lead to a major breakthrough in sodium sulfur battery development. Several years of additional R&D are necessary before commercial development is viable. Impressive performance results have been obtained with test batteries of up to 100 kilowatt hours in size and recent cell designs have demonstrated a specific power of 200 watts per kilogram, which meets the requirement for electric vehicles. It is important that the U.S. maintain its lead over foreign competition in this very promising technology.

The lithium metal sulfide type of battery also operates at elevated temperature and it provides high performance and long life. It is at an early stage of development, but it promises to be a very robust system. Recent cell tests have demonstrated lifetimes of more than 1000 charge/discharge cycles, a very significant achievement. More work on high-performance electrodes, low-cost construction materials and multicell module engineering is needed.

Alkaline batteries under DOE sponsorship have advanced to significantly higher performance and longer lives. Test batteries have been operated both at the National Battery Test Laboratory, a DOE facility at Argonne National Laboratory, and in electric vehicles. Alkaline systems offer greater electric-vehicle range between recharge and much better vehicle performance than lead-acid batteries.

Zinc bromine and zinc chlorine batteries could prove to be very useful, especially in stationary applications such as electric utility networks. A particular advantage of these systems is their projected low cost, which is below that of lead-acid batteries. Materials research, system complexity and halogen safety require additional effort. With continued support the zinc chlorine system will complete its tests in the Battery Energy Storage Test facility and the zinc bromine system can be similarly tested at the 500 kilowatt hour level within the next few years.

Metal air batteries that use aluminum, zinc or iron as the fuel in combination with oxygen taken directly from air may prove attractive for electric vehicles. They can be refueled by adding more metal, and the zinc and iron systems offer the option of electric rechargeability. Key remaining problems are durable high-performance low-cost air electrodes, system complexity, efficiency and cost.

Fuel cells, which have been very successful in space applications, can be modified to provide an efficient hydrogen-fueled electrical power source for vehicle propulsion. The hydrogen gas can be prepared on the vehicle from easily stored liquid fuels, such as methanol or ammonia. This would provide an efficient electric vehicle that is refueled as rapidly as conventional automobiles. The R&D needs for these systems include higher performance, lower cost, longer life, reduced start-up times and better transient response.

Exploratory research on new electrochemical systems has led to the discovery of an inorganic-electrolyte, ambient-temperature lithium cell that appears to permit the lithium electrode to operate much more reversibly than in previous organic-electrolyte cells, and it allows limited overcharge. These characteristics represent a major advance in secondary lithium battery technology, but more work is needed to improve other cell components.

These electrochemical systems have many important scientific technical elements in common and advancement of this field is supported by a strong DOE technology-base research program, which provides new systems, new materials, new knowledge for improvement of the technology, and education of new researchers.

In the area of physical and chemical energy storage technologies, current important activity areas include: thermal energy storage in clathrate compounds, thermal energy storage by means of reversible thermochemical reactions, solid-state radiative heat pumps for use with thermal energy storage systems, phase-change materials for thermal energy storage, hydrogen production and storage for chemical energy storage. Recent results on high-temperature water electrolysis have demonstrated higher efficiencies than low temperature systems. Thermochemical storage of solar energy from systems in which concentrated solar radiation impinges on small particles carried by a gas stream, with the particles acting as the heat exchangers and catalysts to produce energy rich chemicals.

In addition to the achievements just mentioned, important elements of government-sponsored R&D are the education of new scientists and engineers, and the transfer of technology to the commercial sector, as well as spin-off applications in areas where performance, durability, and/or cost requirements are less stringent. The DOE program has been very successful in this area, as evidenced by the following examples: Under DOE sponsorship, Gould, Inc. has developed a novel, maintenance-free sealed lead-acid battery, which has now been commercialized; a new air electrode has been developed for energy savings in chlorine/caustic cells. In the short period of four years, a cooperative DOE-industry-university program developed an electrode which yields a very significant 1-volt reduction in cell potential. Eltech Systems, Inc. is pursuing this technology; the Cr/Fe redox battery system has been transferred to Sohio, Inc. for further development and commercialization; hydrogen production by a simple polymer electrolyte system has been developed and demonstrated in the DOE program and is being commercialized by Hamilton-Standard, Inc.; and a prototype chemical heat pump for use with thermal energy storage systems has been developed, and is being investigated by the private sector for use in sulfuric acid concentrators. A superconducting magnetic energy storage system was built at Los Alamos National Laboratory and is now being tested by Bonneville Power Administration.

DOE-sponsored electrochemical technologies that have found spin-off applications in recent years include: Primary lithium/organic-electrolyte and secondary zinc/nickel-oxide batteries used in small consumer products. Sodium/sulfur and lithium/iron-disulfide batteries were selected by the U.S. Air Force for evaluation for satellite applications. Lithium/iron-disulfide technology is employed in thermal batteries fabricated for the Department of Defense. Aluminum/air batteries are being developed for primary reserve battery applications. Lithium air batteries are being considered for primary battery applications where very high power is important. Zinc air batteries are used in hearing aids. The Department of Transportation is considering fuel cells for use in powering urban buses.

The DOE energy storage program is a vigorous, coordinated program and is pursuing appropriate advanced energy storage systems, with proper attention to education and technology transfer. The future prospects for much greater advances are bright, with continued healthy funding levels. Since there is no single energy storage system that clearly will be appropriate for all intended applications it is necessary to continue with a balanced, moderately diversified program, until clear winners are identified for the important applications for both stationary and mobile energy storage.

The fiscal year 1985 budget of $20 million per year is extremely modest in comparison with the estimated multibillion dollar per year market and associated balance of payments benefits. In order to bring a single energy storage system to the stage of realistic test hardware, a funding level of $1 to $5 million per year is needed. At this point there are several systems worthy of such pursuit. In addition, the technology base research is needed to support the development activities. All together this would mean an appropriate funding level of about $40 million per year for energy storage systems of all types. A minimum funding level of about $27 million per year would support a reasonable program. This is a very modest amount considering the potential benefits for our country. Thank you for your attention.

[The prepared statement of Dr. Cairns follows:]

THE NEED FOR A VIGOROUS DOE ENERGY STORAGE PROGRAM

by

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ABSTRACT

The DOE energy storage program has led the U.S. effort to develop advanced energy storage and conversion systems. Successful development of one or more systems would result in tremendous economic, strategic and environmental benefits to the United States. This document describes the energy storage program, outlines recent progress and future prospects, and justifies continued federal support at a level comparable to or greater than that during recent years.

(revised)

THE NEED FOR A VIGOROUS DOE ENERGY STORAGE PROGRAM

Introduction

The U.S. Department of Energy and its predecessor agencies have supported a coordinated program to develop energy storage technologies since the 1960s. The primary aim of this program is to provide advanced energy storage and conversion systems that will: (a) permit the substitution of coal, nuclear and renewable energy resources for petroleum-based fuels, and (b) improve the efficiency of energy-intensive processes. These objectives would be achieved with an environmental impact significantly more benign than that of our current practice. This document describes the content and scope of the DOE Energy Storage Technologies Program, assesses recent progress and future prospects, and identifies and justifies an appropriate level of federal funding to ensure a reasonable probability of success.

Background

Energy storage systems have long been recognized for their ability to decouple energy supply from energy demand, a feature that offers valuable flexibility in the choice of fuels and energy sources. For example, electrical energy storage in advanced batteries makes possible electric automobiles and vans that can serve the important purpose of shifting a portion of the transportation energy demand away from petroleum, and toward coal, nuclear, and other domestic energy sources. Electric vehicles are also attractive from an energy-conservation point of view, because they would consume substantially less primary (e.g. coal) energy than the equivalent vehicle powered by synthetic fuel. Electrical energy supply systems would also benefit by the use of energy storage as part of the system. Energy storage devices make possible the matching of the load with the energy supply (load-leveling), providing energy storage for periods of several hours to several days. Without energy storage, load following is either impractical (for nuclear) or impossible (for stand-alone wind and solar). Peaking power, which is presently provided by relatively inefficient, petroleum-consuming gas turbines, could be provided by energy storage systems. Because emissions from energy storage devices are either zero or very small, the emission control problem is shifted to central power plants where it is much more readily handled.

The development of viable means to produce, store, transport and utilize hydrogen could result in the substitution of this attractive fuel for petroleum (in vehicles) and natural gas (for heating). The implementstion of advanced methods to store thermal energy could facilitate more efficient heating and cooling of buildings and permit the effective use of solar-thermal technology.

The potential benefits derivable from the development and implementation of advanced energy storage and conversion devices are massive:

- Substitution of domestic energy resources for imported petroleum will improve the U.S. financial and strategic position. For example, the development of advanced batteries suitable for electric vehicle propulsion could result in the reduction in U.S. petroleum consumption by more than 400 million barrels of oil per year (at $30/bbl, $12 B/y).

- Capture of the future international market for energy storage systems will improve the competitive position of the U.S. commercial sector. A new multi-billion dollar-per-year industry to produce energy storage devices would arise.

- Energy storage technologies will promote the utilization of renewable energy resources and centralized energy production systems, resulting in greatly reduced environmental damage.

The development of energy storage systems clearly supports the National Energy Policy Plan,* which calls for "a balanced and mixed energy resource system."

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* October 1983

Description of the DOE Program

The major goal of the DOE energy storage program is to provide advanced energy storage and conversion technologies that can facilitate the substitution of domestic energy resources for imported petroleum and/or permit the more efficient utilization of domestic resources. The program has identified end-use systems, such as electric vehicles and electric load-leveling devices, that exhibit the potential for major petroleum savings if substantial penetration into commercial markets can be realized. Research and development efforts are therefore focused on storage and conversion systems that offer the attractive combination of high performance and low life-cycle costs necessary to compete with the existing petroleum-consuming energy conversion devices.

The energy storage program bridges the gap between fundamental research, traditionally performed at universities, and the corporate role of product development. The program is a coordinated, cooperative effort conducted at national laboratories, universities and corporate laboratories. The most promising systems undergo exploratory development and testing to the point where technology transfer to the private sector is appropriate. Technology-base research efforts to evaluate new systems, materials, and components, to provide supporting research, and to educate the next generation of researchers are a vital part of the energy storage program.

A number of promising energy storage and conversion systems have been developed under DOE sponsorship in recent years. Each has particular advantages as well as significant technical barriers. Within the electrochemical category, these systems are listed in approximate order of priority, considering their likelihood of meeting stringent performance, cost, durability and efficiency requirements.

1. Electrochemical Systems

   - The Sodium/Sulfur Battery

     Invented in the 1960s, this high-temperature, solid-electrolyte battery system offers the potential of exceptional performance using abundant, low-cost active materials. The cost and life of the solid ceramic electrolyte need improvement to meet the demands of the intended stationary and mobile applications. Several years of research, especially in the area of materials science, are needed for this system.

- The Lithium/Metal Disulfide Battery

  This high-temperature, molten-salt-electrolyte battery system was invented by a national laboratory in the early 1970s, and is a candidate for both stationary and mobile applications. The key R&D barriers include development of a low-cost separator and higher-performance electrodes. The U.S. has clear worldwide leadership in this battery technology.

- Alkaline Batteries

  The most promising alkaline-electrolyte system is the zinc/nickel oxide battery. Its power capability and energy capacity are both outstanding, but present cycle life is inadequate. Fundamental research is required to achieve improved understanding of the life-limiting mechanisms -- this knowledge could lead to methods for improving the life of this system without compromising other attractive features. This battery is targeted for mobile applications but must be considered to be in the early development stage.

- Zinc/Halogen Batteries

  The zinc/chlorine and zinc/bromine systems are viable candidates for load-leveling applications and offer the promise of efficient energy storage at a low cost. System complexity and halogen safety are key R&D issues.

- Hydrogen Systems

  High-temperature water electrolysis systems have demonstrated electrical efficiencies superior to those obtained by conventional electrolysis systems, but costs are greater than those for existing hydrogen sources.

- Metal/Air Batteries

  Either aluminum, iron, or zinc can be used with an opposing electrode which consumes oxygen from the air. This feature is attractive because the air electrode eliminates the necessity of carrying part of the reactants in a mobile battery. The engineering and electrochemistry of a practical air electrode, either primary or rechargeable, is a key research project.

- Fuel Cells

  Fuel cells offer a highly-efficient means for utilizing hydrogen (produced on the vehicle from methanol or ammonia) and could be employed as a power source for "unlimited-range" electric vehicles. Primary limitations include system costs and response time to power demand transients.

2. Thermal Energy Storage Systems

   Development of advanced materials that exhibit sufficient stability and thermal efficiency could result in more efficient heating and cooling of buildings, and efficient storage of high-grade thermal energy for industrial processes. A number of new materials have shown promise. Novel heat storage and transport systems are under development. A solid state radiative heat pump is being investigated which could be coupled to thermal storage media in buildings. In another effort, the thermochemical storage of solar energy is being explored. In this system concentrated solar radiation impinges on small particles imbedded in a gas stream, with the particles acting as the heat exchangers and catalysts to produce energy rich chemicals (including hydrogen).

3. Superconducting Magnetic Energy Storage

   This technology offers high efficiency for electrical load-leveling applications. High system costs must be reduced before commercialization can proceed.

Cross-cutting technology-base research studies, not listed above, include:

- Electrochemical phenomena: supporting research to provide better understanding of the complex phenomena that limit the performance and lifetime of electrochemical systems.
- New materials: supporting research aimed at the development of new components required to advance or improve energy storage technology.
- New systems: exploratory research on new electrochemical couples with the potential for higher performance and/or lower life-cycle costs than existing batteries. Ambient-temperature lithium, intermediate-temperature molten-salt, hydrogen/nickel oxide, and zinc/ferricyanide cells are presently under evaluation.
- Battery testing and analysis: evaluation of the performance, life and failure modes of advanced prototype batteries under careful laboratory control.
- Electrochemical technology: identification of new, low-cost catalysts for electrochemical energy conversion systems.
- Corrosion research: applied research to mitigate corrosion processes that limit the lifetime of energy storage and conversion systems.

These cross-cutting activities support the development of all existing energy storage and conversion systems and provide the mechanism for introduction of new systems. As such, they are not prioritized along with the systems listed previously.

Recent Progress

Major advances in battery fabrication techniques and the development of new cell components have permitted the construction of large advanced battery systems. A 100-kWh Na/S battery (sufficient to provide load-leveling for a small commercial building) and a 30-kWh Zn/Br_2 battery have been built and tested. A high-power Na/S cell design has demonstrated 200 W/kg, which can satisfy the projected power requirements for an electric vehicle.

Sophisticated battery testing laboratories have been established and are operating very effectively. The National Battery Testing Laboratory (NBTL), the Battery Energy Storage Testing (BEST) Facility and the Sandia National Laboratory Systems Testing Facility provide comprehensive and unbiased testing of batteries for various energy storage applications. Testing of Pb/PbO_2, Fe/NiOOH, Zn/NiOOH, Zn/Cl_2, Na/S and LiAl/FeS batteries and modules at NBTL has provided extremely valuable feedback to DOE and various battery developers. The BEST Facility has installed and tested an advanced 500-kWh Zn/Cl_2 battery, and cycle-life performance testing of Zn/Br_2, $H_2/NiOOH$ and advanced Pb/PbO_2 batteries at Sandia National Laboratories has identified unanticipated failure modes. This example of strong interaction between DOE, national laboratories and industry has proved to be very beneficial to the energy storage program.

Significant progress has been made in high-performance energy storage and conversion system research:

- New high-temperature LiAl/FeS molten-salt cell components permit more than 1000 deep-discharge cycles (which meet a long-standing goal) and freeze-thaw capability.
- Novel transformation-toughened beta"-alumina ceramics have shown greater resistance to cracking than the single-phase beta"-alumina solid electrolyte now used in high-temperature Na/S cells.
- A new inorganic-electrolyte, ambient-temperature lithium cell, $Li/LiAlCl_4-SO_2/CuCl_2$, shows reversible lithium-electrode behavior and limited overcharge capability. Both of these characteristics represent major improvements over previous

organic-electrolyte cells.

Transfer of DOE-sponsored technology to the private sector has been very successful:

- A novel maintenance-free, sealed lead-acid battery, capable of 1000 deep cycles, has been developed and commercialized by GNB, Inc.

- New air-electrode technology has been developed for use in chlorine/caustic cells. A cooperative DOE/industry/university program was completed in 4 years, resulting in a one-volt reduction in cell potential. This breakthrough offers major energy savings in chlorine production, and a one-year lifetime has already been demonstrated in a commercial cell (Eltech Systems Corp.).

- The Cr/Fe redox battery system has been transferred to Sohio, Inc. for further development and commercialization.

- The development of solid-polymer electrolyte water electrolysis systems (General Electric and Hamilton-Standard) has resulted in private-sector commitments to commercialization strategies which address small user markets.

- The development of a prototype sulfuric acid/water chemical heat pump (Rocket Research Corp.) has led to successful characterization of these systems. The private sector is now committed to identifying commercial ventures, with initial spinoff applications for sulfuric acid concentrators.

- Construction of an underground compressed air field test facility was accomplished by Battelle Pacific Northwest Laboratory near Pittsfield, Illinois. After initial tests (1983) the facility was transferred to the

Electric Power Research Institute (EPRI).

- Construction of a superconducting magnetic energy storage system was accomplished by Los Alamos National Laboratory. It has been used to damp power oscillations on the Bonneville Power Administration/Western U.S. Power System.

- A fiber-composite material flywheel with a 79-wh/kg capacity was demonstrated. A DOT-sponsored flywheel bus is being supplied with a DOE-sponsored Garrett Flywheel/ Electric Drive System, Volvo Motors is developing a flywheel bus drive system, and NASA is planning use of composite flywheels for space applications.

The overall direction of the energy storage program has been to encourage private-sector commercialization (or utilization by other federal agencies) of near-term technologies with "spin-off" possibilities. A number of DOE-sponsored electrochemical technologies have found spin-off applications in recent years:

- Primary Li/organic-electrolyte and secondary zinc/nickel-oxide batteries are used in small consumer products.

- Sodium/sulfur and lithium/iron-disulfide secondary batteries were selected by the U.S. Air Force for evaluation for satellite applications.

- Lithium/iron-disulfide technology is employed in thermal batteries fabricated for the Department of Defense.

- Aluminum/air batteries are being developed for primary reserve batteries, lithium/air batteries are being considered for primary battery applications where very high power is required, and primary zinc/air batteries have been commercialized for use in hearing aids.

- Fuel cells are being considered by the Department of Transportation for use as power sources for urban buses.

Future Prospects

At this time, there are no clear winners of the (international) race to develop an energy storage technology capable of substantial penetration of commercial markets. Although several technologies are viable candidates, none in its present form can meet the stringent performance, cost, durability, and efficiency requirements. However, it is important to keep in mind the history of energy storage system development. For example, during the 1800s only a single practical battery system emerged -- namely lead-acid. By the early 1900s iron/nickel oxide batteries became available, in the 1960s cadmium/nickel oxide and zinc/silver oxide batteries were developed, and in the 1970s hydrogen/nickel oxide batteries were employed in space applications. These systems have seen increasing application in both aerospace and consumer markets. It is clear that new systems require significant periods of R&D before they are ready for the very competitive market place, but with proper incentives and with federal involvement winners will emerge. Thus, while the probability of success in any one energy storage system may be 50 percent or less, continued research is virtually certain to result in the successful development of one or more of these high-performance systems.

Recent funding levels* for the energy storage program have permitted the sustained development of only a few systems at modest effort levels. As the most promising systems advance to the stage where testing of larger systems becomes appropriate, increased funding levels are necessary to ensure proper evaluation. For example, at least five electrochemical energy storage systems (sodium/sulfur, zinc/bromine, lithium/metal disulfide, zinc/nickel oxide and metal/air) show sufficient promise to merit some level of serious development activity, which requires $1M-$5M per year per system. Recent funding levels** for the electrochemical part of the energy storage program have permitted only the sodium/sulfur and zinc/bromine systems to undergo substantial development efforts. It is strongly recommended that the funding level for the total energy storage program be established at an appropriate level to maintain development (and supporting research) efforts on 5-10 of the most promising candidate energy storage/conversion systems. It is suggested that a $40M/year energy storage budget is appropriate, and a budget of $27M/year is the minimum level necessary to support a reasonable program.

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* Approximately $25M in FY 1984 and $20M in FY 1985.
** Approximately $18M in FY 1984 and $16M in FY 1985.

Provided that an adequate funding level is maintained, prospects look bright; successful development of one or more advanced energy storage systems can be expected in the 1990s. This can provide a very significant cushion against possible future petroleum shortages, and can play a major role in avoided costs of new power plants.

Need for Federal Funds

Leadership in energy storage technology presently resides in the U.S., Japan and Western Europe. The central focus of this nation's R&D has been the Energy Department's programs to develop advanced energy storage and conversion systems for electric vehicles and electric utilities. As a result of these programs, the U.S. has an apparent technical lead in several of the candidate systems and a competitive position in others. However, the U.S. does not enjoy a clear-cut superiority, and in recent years we have been an importer of this technology. Continued federal support would allow the U.S. to maintain its momentum to establish a firm competitive edge in energy storage and conversion technology, and in the education of researchers for this important field.

It is clear that industry alone will not pursue battery R&D at the required level of effort. Some of the reasons are:

1. There is a cost barrier to the industrial development of advanced storage/conversion systems suitable for electric vehicle or utility load-leveling use. For example, only 1.7 percent of the revenue from sales made by battery developers is returned to their R&D program. Of that, 90 percent is used to improve products for existing markets, and support for R&D work directed at long-term potential is at most 0.17 percent of sales. The reason for lack of industrial spending on this R&D is that there is no well-developed market for either electric vehicle or utility load-leveling systems; therefore the cost and risk are both high.

2. The major markets for advanced storage/conversion devices are the automobile manufacturers and the electric utilities. Both have narrow profit margins which make technology shifts risky. For example, to make current-technology batteries profitable to utilities, the designs must be improved to double the system life (from the current 10 to about 20 years), and the costs must be reduced by about 50 percent. This would require large investments over a relatively long period of time (5 to 15 years), requiring resources that neither the utilities nor the battery manufacturers have.

3. There is a technical risk which adds additional weight to the economic risk. This risk involves the development of energy storage systems that require substantial and simultaneous improvement in four competing areas of performance: specific energy, specific power, cycle life, and cost. For example, without extensive development, electric vehicles will continue to suffer from an unfavorable position relative to internal-combustion engine vehicles in terms of initial cost and performance.

4. There are a number of viable candidates for both electric vehicle and stationary energy storage applications. At this time, it is not possible to identify an eventual winner, so individual companies are reluctant to invest their funds.

5. New provisions of the Economic Recovery Tax Act (PL 97-34) offer tremendous advantages to companies who invest in new production capacity. This will cause even more emphasis to be placed on near-term investments in conventional technology and increases the need for government participation in long-term R&D efforts.

6. U.S. companies are not operating in a totally "free" market. Developers in Japan, West Germany and England are receiving strong financial support from their governments. Without strong federal support, American industry will find itself at a disadvantage with respect to foreign competition. This can only injure further the U.S. balance of trade.

Long-range R&D on advanced systems for energy storage is a highly appropriate use of public funds because of the broad range of positive impacts that could accrue to various national programs (nuclear, fossil, and renewable energy) and national problems (dependence on foreign petroleum, federal deficits, and damage to the environment). The absence of existing markets for the eventual application of advanced storage systems makes long-range R&D a high-risk undertaking, which underscores the crucial need for continued government support.

Recommendation

It is recommended that the Energy Department's Energy Storage Technologies Program continue to receive the support that has made possible the existing strong R&D effort, and which has involved major research institutions, including national laboratories, major universities and industrial laboratories. Specifically, continued Federal support at a level of $27-$40M per year should provide funds adequate for research and development on the most promising candidate systems to the point of technology transfer to industry.

Mr. Valentine. Thank you, sir.

Mr. Carlsmith.

STATEMENT OF ROGER S. CARLSMITH, DIRECTOR, CONSERVATION AND RENEWABLE ENERGY PROGRAM, OAK RIDGE LABORATORY, OAK RIDGE, TN

Mr. Carlsmith. Thank you, Mr. Chairman. My name is Roger Carlsmith. I'm director of the Conservation and Renewable Energy Programs at the Oak Ridge National Laboratory. I'm very pleased to be here again this year to discuss with you some of the research at the Oak Ridge National Laboratory on energy conservation. For several years ORNL has been responsible for managing substantial fractions of the Department of Energy's programs on both electric energy systems and on chemical and physical storage. We have developed integrated R&D programs in which the participants are selected based on their knowledge and experience on specific tasks. At present 42 percent of the work is done by industrial participants, 9 percent at universities, 4 percent at utility companies, and 45 percent at the national laboratories. Both programs have already demonstrated their usefulness by successfully completing several developments. Continuation of these programs at viable levels will help keep our energy technology up to date so that we can meet the coming challenges of renewed energy shortages and intensified foreign competition.

The Electric Energy Systems Program consists of research to advance the technology in the country's electric power network. Principal subareas in the ORNL portion of the program are automation of transmission and distribution systems, new materials to increase the efficiency of operation, and R&D to increase reliability. Individual utilities do not carry on the type of research covered by this program. Since they operate in a highly regulated environment, utilities lack market incentives to invest in long-term or high-risk R&D. Also, most electric utilities are highly constrained in the level of R&D expenditures permitted by their public utility commissions. The Electric Power Research Institute and other utility-sponsored organizations and equipment manufacturers focus most of their R&D on near and midterm projects, which are of immediate importance to them, but do not address some of the national concerns. Program planning by DOE and ORNL is closely coordinated with that of the Electric Power Research Institute to avoid any duplication of effort, as pointed out earlier by Mr. Mannella.

As you know the administration proposal for fiscal year 1986 would reduce DOE's electric energy systems budget to $10 million, compared with $20.7 million in fiscal year 1985. This sudden drop in funding level would obviously require termination or curtailment of a large part of the program. Some of the areas that would be affected are the following:

The Athens automation and control experiment, which was initiated several years ago. This experiment is intended to determine how much power losses and demand peaks can be reduced by means of modern concepts and automated control of an electrical distribution system. The experiment is to be conducted on the system of the Athens Utility Board at Athens, TN. Participants will be the Oak Ridge National Laboratory, the Tennessee Valley Authority, the Electric Power Research Institute, the Tennessee Valley Public Power Association, several manufacturers and the host utility company. Approximately $6 million has already been invested in the design and procurement of equipment. The automation equipment has been delivered and is partially installed. The project plan calls for completion of equipment installation in fiscal year 1985, tests and start of data acquisition in fiscal year 1986, and then 2 years of data gathering and analysis in fiscal years 1987–88. Instead, the President's budget would provide reduced funding in fiscal year 1986 for a closeout of the project in that year, before most of the intended results can be obtained.

A second area in Electric Energy Systems that would be reduced by the proposed budget is the development of new materials. This area has been noteworthy in the past few years for the large number of successful developments that have been achieved. In my testimony last year before this subcommittee I discussed the exciting results that have been obtained in a new process for production of high performance zinc oxide varistors. Since that time the process has been successfully moved from laboratory scale to preproduction scale and two companies have expressed interest in a cooperative venture with ORNL to develop it further.

Other current developments in materials technology include a method for monitoring the temperatures inside power transformers by means of optical fibers and a method for producing amorphous metal cores for electrical equipment, which avoids the usual problems of having the material become excessively brittle. Another topic that occupies a central position in electrical technology is that of dielectrics. These are materials that can be used as electrical insulators. ORNL researchers have already made important advances in understanding the basic mechanisms occurring within gaseous dielectrics. Future work is scheduled to address similar questions in liquid and solid dielectrics. Unfortunately for the continuation of these projects the President's budget contains no funds for materials development in fiscal year 1986. Thus the implication is that all of the ongoing materials work would be stopped and that no new projects would be undertaken.

A third Electric Energy Systems area is that of electromagnetic pulse, which is commonly abbreviated as EMP. These phenomena occur as side effects from the detonation of nuclear weapons. EMP can potentially disable large portions of the civilian power network of the country. The DOE/ORNL Program plan seeks to develop and validate analytical models, which can then be used to predict the effects and suggest ways to provide protection. The plan lays out a 6-year schedule for the project ending in fiscal year 1988. However, the fiscal year 1986 budget proposal calls for a 40-percent reduction in funding, leading to a considerably stretched out schedule. The results of the EMP studies will have important implications for design of power systems and the topic is clearly one in which the Government has a primary responsibility.

Still another Electric Energy Systems area which would be eliminated in the proposed budget is high voltage direct current research. By using direct current transmission, large quantities of electric energy can be shipped between parts of the country which presently cannot exchange energy due to limitations of the existing system. The potential cost savings of such an energy exchange capability are large. The ongoing DOE/ORNL Program will assist in the development and evolution of a direct current transmission network.

In summary, I've described a few of the important results being obtained and expected from the Electric Energy Systems projects. Each of the project areas has been proceeding according to a carefully laid-out program plan, which assumed fiscal year 1986 funding at levels comparable to those in 1985. The results are being effectively transferred to the private sector as they are obtained. A sudden drop in funding in 1986 would result in a loss of much of the work that has been done over a period of years.

I will now discuss, more briefly, the ORNL Programs in Thermal Energy Storage. ORNL has managed a major portion of the DOE Thermal Energy Storage Program since the inception of the program in fiscal year 1976. The goal of this research is the development of technologies which make possible three important conservation measures: Shifting electric utility loads from peak times to offpeak times, recovery of industrial waste heat, and increased use of solar energy by storing the energy for use when the Sun is not shining.

In my testimony last year, before this subcommittee, I described several products from this research program which have already been put into commercial use. In each of these cases DOE funds paid for the initial development and for an economic analysis which showed that the material could be manufactured and sold profitably. These results were then made available to the private sector and to companies that were in a position to market the development.

During the past year additional progress has been made on the development of high temperature heat storage material for recovering industrial waste heat. This material, which is a sodium-barium carbonate mixture contained in a magnesium oxide matrix, is nearly ready for the critical step of technology transfer to industry. Pellets suitable for use in packed beds have been produced, and over 6,000 hours of thermal cycling has been successfully completed in a sample packed bed. The initial application for this development is expected to be in recovering heat in brick manufacture. A preliminary economic analysis gives encouraging results, and a comprehensive economic and technical evaluation will soon be completed. A confirmation of favorable economics will set the stage for a proof-of-concept test to be sponsored jointed by DOE and industry.

Within the limited funds available, the Thermal Storage Program is also continuing exploratory research on several other potential storage materials. These include freon clathrates, ammoniated salts, and self-encapsulating metal eutectics. With each of these materials the goal is to find systems that can reduce the cost of heat storage and thus make it possible to use energy that's now being wasted. We're encouraged by the progress that's being made in thermal storage and hope to be able to tell you about additional successes in future years.

Thank you.

[The prepared statement of Mr. Carlsmith follows:]

Impacts of the FY-86 Budget on ORNL Research Programs in Electric Energy Systems and Thermal Energy Storage

Roger S. Carlsmith
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Testimony to the
Subcommittee on Energy Research and Production
Committee on Science and Technology
U.S. House of Representatives

March 7, 1985

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*Operated by Martin Marietta Energy Systems under contract DE-AC05-84OR21400 with the U.S. Department of Energy.

Impacts of the FY-86 Budget on ORNL Research Programs in Electric Energy Systems and Thermal Energy Storage

by

Roger S. Carlsmith
Director, Conservation and Renewable Energy Program
Oak Ridge National Laboratory*

I am pleased to be here again this year to discuss with you some of the Oak Ridge National Laboratory (ORNL) research on energy conservation. For several years ORNL has been responsible for managing substantial fractions of the Department of Energy's programs on Electric Energy Systems and on Physical and Chemical Storage. We have developed integrated R&D programs in which participants are selected based on their knowledge and experience on specific tasks — 42% of the work is done by industrial participants, 9% at universities, 4% at utility companies, and 45% at the national laboratories. Both programs have already demonstrated their usefulness by successful completion of several developments. Continuation of these programs at viable levels will help to keep our energy technology up-to-date so that we can meet the coming challenges of renewed energy shortages and intensified foreign competition.

The Electric Energy Systems program consists of research to advance the technology in the country's electric power network. Principal sub-areas in the ORNL portion of the program are automation of transmission and distribution systems, new materials to increase the efficiency of operation, and R&D to increase reliability. Individual utilities do not carry on the type of research covered by this program. Since they operate in a highly regulated environment, utilities lack market incentives to invest in long-term or high-risk R&D. Also, most electric utilities are highly constrained in the levels of R&D expenditures permitted by their public utility commissions. The Electric Power Research Institute (EPRI), other utility-sponsored organizations, and equipment manufacturers focus most of their R&D on near- and mid-term projects which are of immediate importance, but do not address some national concerns. Program planning by DOE and ORNL is closely coordinated with that of EPRI to avoid any duplication of effort.

As you know the Administration proposal for FY-86 would reduce DOE's Electric Energy Systems budget to $10 million, compared with $20.7 million in FY-85. This sudden drop in funding level would obviously require termination or curtailment of a large part of the program. Some of the areas that would be affected are the following.

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The Athens Automation and Control Experiment was initiated several years ago. This experiment is intended to test the decrease in power losses and demand peaks that can be obtained by means of modern concepts in automated control of an electrical distribution system. The experiment is to be conducted on the system of the Athens Utility Board at Athens, Tennessee. Participants will be the Oak Ridge National Laboratory, the Tennessee Valley Authority, the Electric Power Research Institute, the Tennessee Valley Public Power Association, several manufacturers, and the host utility company. Approximately $6 million has been invested to date in the design and procurement of equipment. The automation equipment has been delivered and is partially installed. The project plan calls for completion of equipment installation in FY-85, operability tests and the start of data acquisition in FY-86, and then two years of data gathering and analysis in FY-87 and FY-88. Instead, the President's budget would provide reduced funding in FY-86 for a closeout of the project in that year before most of the intended results have been obtained.

A second area in Electric Energy Systems that would be reduced by the proposed budget is the development of new materials. This area has been noteworthy in the past few years for the large number of successful developments that have been achieved. In my testimony last year before this subcommittee, I discussed the exciting results that have been obtained in a new process for production of high performance zinc oxide varistors. Since that time the process has been successfully moved from laboratory scale to preproduction scale, and two companies have expressed interest in a cooperative venture with ORNL to develop it further.

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A third Electric Energy Systems area is that of electromagnetic pulse (commonly abbreviated as EMP). These phenomena occur as side-effects from the detonation of nuclear weapons. EMP can potentially disable large portions of the civilian power network of the country. The DOE/ORNL program plan seeks to develop and validate analytical models which can then be used to predict effects and suggest ways to provide protection. The plan lays out a six-year schedule for the project, ending in FY-88. However, the FY-86 budget proposal calls for a 40% reduction in funding, leading to a considerably stretched-out schedule. The results of the EMP studies will have important implications for design of power systems, and the topic is clearly one in which the government has a primary responsibility.

Still another Electric Energy Systems area which would be eliminated in the proposed budget is high voltage direct current (HVDC) research. By using direct current transmission, large quanities of electric energy can be shipped between parts of the country which presently cannot exchange energy due to limitations of the existing system. The potential cost savings of such an energy exchange capability is large. The on-going DOE/ORNL program will assist in the development and evolution of an HVDC transmission network.

In summary, I have described a few of the important results being obtained and expected from the Electric Energy Systems projects. Each of the project areas has been proceeding according to carefully laid-out program plans which assumed FY-86 funding at levels comparable to those in FY-85. The results are being effectively transferred to the private sector as they are obtained. A sudden drop in funding in FY-86 would result in the loss of much of the work that has been done over a period of years.

I will now discuss, more briefly, the ORNL programs in Thermal Energy Storage. ORNL has managed a major portion of the DOE Thermal Energy Storage program since the inception of the program in 1976. The goal of this research is the development of technologies which make possible three important conservation measures: shifting electric utility loads from peak to off-peak times, recovery of industrial waste heat, and increased use of solar energy by storing the energy for use when the sun is not shining. In my testimony last year before this subcommittee I described several products from this research program that have already been put into commercial use. In each of these cases DOE funds paid for the initial development and for an economic analysis which showed that the material could be manufactured and sold profitably. These results were then made available to private sector companies that were in a position to market the development.

During the past year additional progress has been made on the development of a high-temperature heat storage material for recovering industrial waste heat. The material, a sodium-barium carbonate mixture contained in a magnesium oxide matrix, is nearly ready for the critical step of technology transfer to industry. Pellets suitable for use in packed beds have been produced, and over 6,000 hours of thermal cycling have been successfully completed on a 40 lb sample packed bed. The initial application for this development is expected to be recovering heat in brick manufacture. A preliminary economic analysis gives encouraging results, and a comprehensive economic and technical evaluation will soon be completed. A confirmation of favorable economics will set the stage for a proof-of-concept test to be sponsored jointly by DOE and industry.

Within the limited funds available, the thermal storage program is also continuing exploratory research on several other potential storage materials. These include freon clathrates, ammoniated salts, and self-encapsulating metal eutectics. With each of these materials, the goal is to find systems that can reduce the cost of heat storage and thus make it possible to use energy that is now being wasted. We are encouraged by the progress that is being made in thermal storage and hope to be able to tell you about additional successes in future years.

Mr. **Valentine.** Thank you, sir.

Doctor, the proposed reduction in Energy Storage Program for fiscal year 1986 is about $4 million.

Dr. **Cairns.** Yes.

Mr. **Valentine.** One must almost apologize for talking in terms of such petty cash, with all of the billions I have to stop and think, just $4 million——

Dr. **Cairns.** Million dollars.

Mr. **Valentine.** Would you tell us how, in a few words, how this will affect the research at Lawrence Berkeley Laboratory?

Dr. **Cairns.** Well, this will affect the total of the DOE program, not just the program at Lawrence Berkeley Laboratory and to put this in perspective it needs to be remembered that we, in the Energy Storage Program, have had significant reductions in funding over the last 2 or 3 years, so this additional $4 million, which is about 20 percent, on top of the previous year's reductions will cause further loss of research and development efforts and especially will impact such systems as the zinc bromine system. With this reduction in funding all of the systems now undergoing the later stages of development will not be able to be pursued any more and so we are at the point of having to pick and choose among the systems that will continue to be developed, so that would leave sodium sulfur as the one major system undergoing additional development work and cause the dropping of the zinc bromine and the failure to initiate development on a number of other promising systems.

Mr. **Valentine.** Well, could you define this in terms of a reduction in education opportunities? Is that a legitimate approach to it?

Dr. **Cairns.** Yes, it is a legitimate approach, because one-third of all of the funding that the Lawrence Berkeley Lab lead center is responsible for goes to universities and that funding sponsors the masters and Doctor of Philosophy degrees of a large number of students. At Berkeley alone we have about 40 students, mostly taking Doctor of Philosphys, working on these programs, and so a 20-percent reduction in funding of the overall program would result in a similar reduction in opportunities for these students and the research that they're doing. That would be a major impact on the total education of electrochemists and electrochemical engineers in this country.

Mr. **Valentine.** Could you elaborate on the philosophy of conducting research and development across a wide range of candidate battery designs, as opposed to focusing a major effort on, say, just one, two or three candidates that might have the highest potential?

Dr. **Cairns.** Yes, sir. A major portion of this energy storage program encompasses exploratory research. There are literally millions of possibilities in principle that one could write down on paper, but only a very small fraction of those possibilities may turn out to be practical. And at a very low cost for the exploratory research, the program can identify the promising candidates for the very high performance systems of tomorrow. Without following this philosophy of funding the exploratory work we won't have any new options for the future and it's necessary to, at a very low cost per system, evaluate these new ideas and carry the most promising ones only forward to the development stages and that has been the philosophy of operation of this program so far.

Mr. VALENTINE. Thank you, Doctor.

Mr. Carlsmith, will these—I imagine obviously these reductions would have some effect on personnel levels at Oak Ridge. To what extent would the programs at that laboratory of electric energy systems and energy storage systems be effected?

Mr. CARLSMITH. In my prepared remarks I discussed the impacts on electric energy systems projects. And briefly the work on the Athens project in automation would be closed out. The work on materials, new materials would be discontinued. The work on EMP would be slowed down and stretched out and the work on high-voltage systems would be discontinued. In dollar terms the impact would be to reduce the ORNL electric energy systems program from $7 million in fiscal year 1985 to $3.8 million in fiscal year 1986. That would result in the loss of about 24 people in the Oak Ridge National Laboratory staff. And perhaps even more important the loss of a larger number of people in the universities and industrial concerns that are doing much of the work that is managed by the Oak Ridge National Laboratory.

I think this loss of people is particularly significant when you think that these programs were designed to be long-term programs extending over a period of years and once you stop a program like that in midstream it's not possible later to put the team back together that was working on it and start back up where you left off, so that you're losing not only the direct results that you were expecting to get in the near term, but also the investment that's been made over a period of years in the past.

Now, with regard to the thermal energy storage, the proposed budget in 1986 is actually slightly larger than in 1985 and it goes up from a little over $2 million to about $3 million, as I remember. and perhaps that's the best one can hope for in a year like this, but I would remind you that that program was $30 million just a few years ago and it's been cut in the last 4 years so much that only some very limited exploratory work can now be done under the program, rather than the large effort that was possible a few years ago.

Mr. VALENTINE. Well, I think you make a very good point. What you say about the inability to put Humpty Dumpty back together again applies not here, but all up and down the line where we, the government, in many instances alone and hand in hand with local Governments and private enterprises involved in research and development projects, if they are terminated it's not—it would be very difficult to accumulate that talent and get it back together. Get it back from changed lives and directions. I've been very much impressed by what I have heard here today and I think that—I hope that the Congress will heed the message that you have brought to us. I would say to you in all seriousness not, you know, we've said a few things here today in jest, but apply what pressure you can on the executive branch of this Government, the Chief Executive. Both of you have ways to do that and be sure that he, and those who advise him, know the very special and particular programs, even something like the—say the food and nutrition program, which is supported so heavily by the Federal Government, if that goes down the drain, and I know you don't have anything at all to do with that, but that could be put back together, a lapse and the repercussions of a year or two and there are so many other programs, but this one cannot. If it folds, unless somebody comes there to fill the void, unless money comes from other sources, which is not likely to happen, then we will have—we'll be set back at a time when that's the last thing that we need in the development of this Nation.

Do you gentlemen have anything else to say?

Mr. CARLSMITH. No, sir.

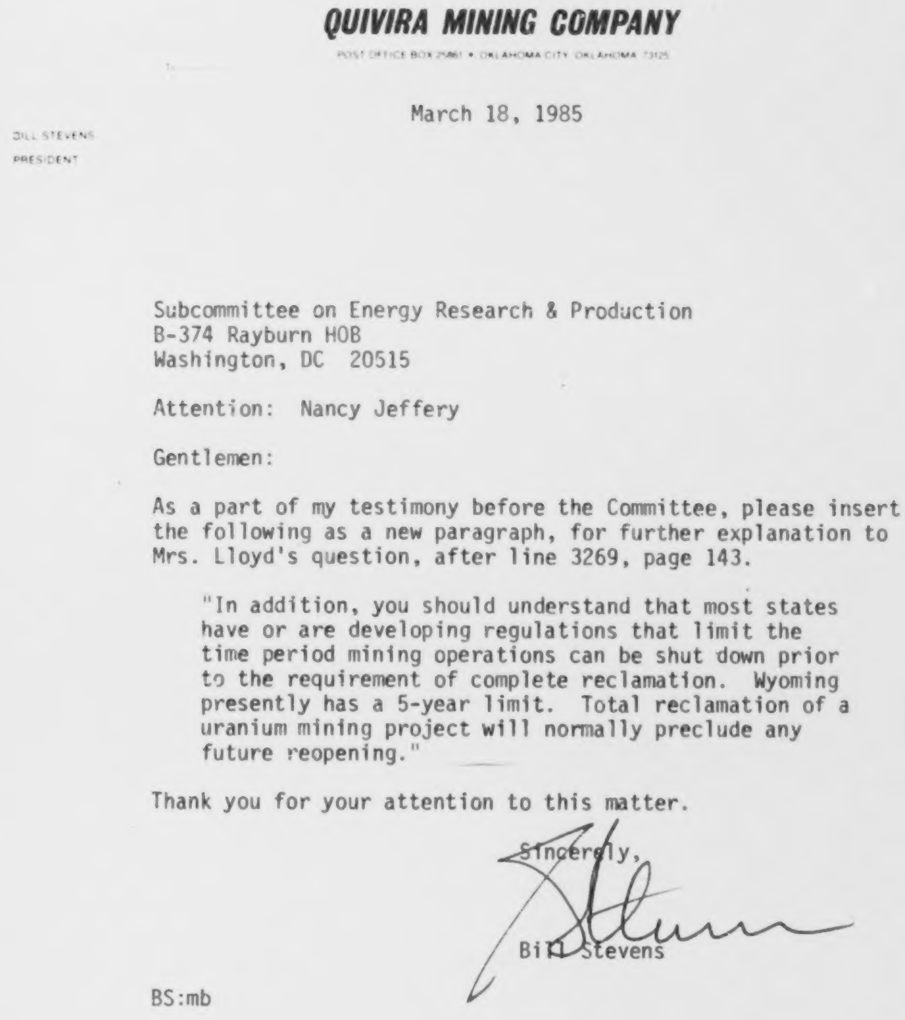
Dr. CAIRNS. No, sir. Thank you.

Mr. VALENTINE. Does anybody else have anything for the good of the order. No, I take that back. Thank you very much for coming. Excuse me. The subcommittee will meet again tomorrow at 8:30 a.m. in room 2318, Rayburn, to hear from DOE witnesses on the magnetic fusion energy program. We stand recessed until that time.

[Whereupon, at 12 noon, the subcommittee recessed, to reconvene at the call of the Chair.]

APPENDIX I

ADDITIONAL STATEMENTS FOR THE RECORD



QUIVIRA MINING COMPANY
POST OFFICE BOX 25861 • OKLAHOMA CITY, OKLAHOMA 73125

BILL STEVENS
PRESIDENT

March 18, 1985

Subcommittee on Energy Research & Production
B-374 Rayburn HOB
Washington, DC 20515

Attention: Nancy Jeffery

Gentlemen:

As a part of my testimony before the Committee, please insert the following as a new paragraph, for further explanation to Mrs. Lloyd's question, after line 3269, page 143.

> "In addition, you should understand that most states have or are developing regulations that limit the time period mining operations can be shut down prior to the requirement of complete reclamation. Wyoming presently has a 5-year limit. Total reclamation of a uranium mining project will normally preclude any future reopening."

Thank you for your attention to this matter.

Sincerely,

Bill Stevens

BS:mb

IGT
Headquarters

Bernard S Lee, President
312/567-3741

March 18, 1985

Congresswoman Marilyn Lloyd
Chairman, Subcommittee on Energy
  Research and Production
House Science & Technology Committee
B-374 Rayburn House Office Building
Washington, D. C. 20515

Dear Chairman Lloyd:

I would lke to request inclusion of this letter in the record for your Subcommittee hearing on the FY'86 DOE Budget Authorization for electric energy systems, energy storage systems, and small-scale hydropower systems.

My name is Bernard S. Lee. I am President of IGT, a not-for-profit energy R&D organization in Chicago.

The 99th Congress faces the difficult task in the coming year of making decisions which lead to cutting the Federal budget deficit. While undertaking this challenge, the Congress should recognize the need for high-quality technological development that will enable us to achieve a state of energy readiness and security.

The energy storage systems programs under consideration by your Subcommittee are of particular interest to IGT.

There are many cyclic high temperature industrial processes, e.g., kilns for ceramics or bricks, which discard heat during the cooling part of the cycle and, therefore, waste considerable high temperature energy. If this energy could be stored at high temperature and used in the heating part of the next cycle, as much as 45% of the energy used in a typical kiln could be saved. Current high temprature Thermal Energy Storage (TES) is accomplished by heating a ceramic brick during "charging" and cooling the brick to recover the heat during "discharging." Because of the low energy storage capacity of ceramic brick, this results in large, heavy heat storage systems. Increased energy storage capacity can be achieved using phase-change materials which would be alternately melted and frozen in the desired temperature range. The energy would be stored during melting and be released when the material solidifies. In all previous systems designs, this has proven impractical because of the great resistance to heat flow through the solid material.

IGT has developed a composite media in which a salt with the desired melting temperature is contained within a porous ceramic. Because of the method used to fabricate this media, the composite TES system stores large amounts of heat while avoiding the heat transfer problems associated with the formation of solid salt. The composite media is designed so that the molten salt remains within the porous ceramic throughout the temperature cycle. When compared to ceramic bricks, the composite TES system results in 36% less weight, 58% less volume, 37% less cost, as well as increasing efficiency by more than 25%.

I appreciate this opportunity to present my views. I will be happy to answer any questions.

Sincerely yours,

ENERGY RESEARCH CORPORATION
CORPORATE HEADQUARTERS
3 GREAT PASTURE ROAD, DANBURY, CONNECTICUT 06810 203-792-1460
WASHINGTON OPERATIONS
SUITE 200, 1527 K STREET, N.W., WASHINGTON D.C. 20006 202-955-9321

A SUBSIDIARY OF
ST.JOE
MINERALS CORPORATION

WL 85-12

March 6, 1985

The Honorable Marilyn Lloyd, Chairwoman
House Science & Technology Committee
Subcommittee on Energy Research & Production
B-374 Rayburn House Office Building
Washington, D.C. 20515

Dear Congresswoman Lloyd:

The Energy Research Corporation, a subsidiary of St. Joe Minerals Corp., a Fluor Company, is one of a very few firms soley dedicated to research, development and manufacure of batteries and fuel cells. With the press of a very tight hearings schedule this year, I am writing to request that the enclosed testimony be accepted and distributed to the Members, as you consider the DOE FY 1986 Budget Request for Energy Storage.

The Zinc-Bromine Program is a cooperative effort between DOE and the Electric Power Research Institute (EPRI) to complete the R&D phase and build/test a prototype utility battery for test at the EPRI B.E.S.T. facility in New Jersey in 1988. The Congress appropriated $1.5 million for the first of the three-year project, in the FY 1985 Continuing Resolution. I urge your sustained support in order that DOE meet its joint agreement obligations to the DOE/EPRI effort. The current DOE Request contains only $0.2 million for FY 1986, with $1.9 million needed to keep the work in tune with the EPRI-funded portion, as both agencies have important milestones contributive to reaching the overall scheduled installation date in 1988.

I hope the enclosed statement provides the necessary insight to help you in your deliberations on this portion of the DOE Energy Storage Program.

Very truly yours,

Donald R. Glenn
Director-Program Development
and Washington Operations

enc.

cc: J.Dugan, Staff Director

ENERGY RESEARCH CORPORATION

Statement of Donald R. Glenn

Director

Energy Research Corporation

U.S. HOUSE OF REPRESENTATIVES

Committee on Science and Technology

Subcommittee on Energy Research and Production

Marilyn Lloyd, Chairwoman

Hearings on Fiscal Year 1986 Authorization

for

The Department of Energy's Energy Storage Program

March 7, 1985

ENERGY RESEARCH CORPORATION

Statement

I am Donald R. Glenn, Director of Program Development, for the Energy Research Corporation, a subsidiary of St. Joe Minerals Corp., a Fluor Company. I am submitting this statement in support of the Department of Energy FY 1986 Budget deliberations by your Subcommittee, in Energy Storage.

ERC, in celebrating its 15th Anniversary this year, has maintained our founding abjective, to engage in all aspects of electrochemical energy conversion and storage functions. In pursuit of this charter, ERC has grown to a staff of 150, with approximately 40% possessing directly relevant degrees. ERC is among the top two or three largest companies developing advanced batteries and fuel cell technologies, and may be the largest firm dedicated soley to producing electrochemical power components and systems. ERC is located in Danbury, Connecticut.

Recently released reports by the Worldwatch Institute[1] and the Congressional Research Service[2] point out that utility planners are no longer looking to large baseload plants to add capacity to the uncertain growth trends facing our country in the next 20 years. Due to troublesome and lengthy licensing procedures and environmental controversies, the use of load-leveling and peak shaving techniques will be employed wherever possible, as a least-cost option to adding new capacity. ERC's zinc-bromine battery program provides one very important capability to this end, and is the subject of this statement.

Zinc-Bromine Batteries for Utility Load Leveling

Since 1982, when ERC became involved in Zinc-bromine technology. the prospects for successfully completing this development have measurably improved. ERC's technical staff have been able to solve several key challenges that impeded progress prior to 1982. At this point, an explanation of this battery's operating principles may help to understand the attractiveness of this approach for large-scale energy storage for load-leveling missions.

The zinc-bromine battery is unique in that its reactions are controlled by two electron-emitting reactant streams. One stream, the anolyte (or negative electrolyte) flows through one side of a cell, while the other stream, the catholyte (or positive electrolyte) flows on the other side of the cell. While separated physically from mixing within the cell, the zinc and bromine react electrochemically causing ions to flow across the separator during discharge. In the charging mode, the chemicals revert back, as the charging electrons reverse the chemical reactions.

This battery is attractive because it can be inexpensive to operate (100 $/kWh), has reasonable efficiency (75%) and is very simple to operate. ERC believes the battery can best serve as a load-leveling capability to utilities and large industrial users, offsetting incremental capacity additions (usually gas turbines) to meet peak demands, or to load follow during transient demand periods. While other applications may be technically feasible for this technology, such as electric vehicle power, the utility directed interests offer a superior market-entry point for this system. To this end, DOE joined with EPRI to stimulate completion of technology development and the building and testing of a utility-scale battery at EPRI's B.E.S.T. facility in 1988. Through a competitive process, the ERC concept has been selected by DOE and EPRI for this program, in separate butrelated contracts with cost-sharing provided by ERC. ERC has since secured other private interests to compliment this program. Our parent company, Fluor Corporation, has made a major commitment to assist ERC in this program and to commercialize this battery upon successful completion of the B.E.S.T. facility test phase, with verification at that time of the projected low system capital and operating costs, and developing market opportunities.

The total funding for the three year joint effort is $11.25 million with 44%, the DOE portion,. To fulfill the DOE segment, that of completing the core technology development, $1.92 million is required in FY 1986 and $1.63 million in FY 1987. Congress appropriated $1.5 million in FY 1985. This effort is leveraged by a $4.45 million contribution from EPRI and $1.88 million by ERC. I ask for your support to finish this exciting endeavor.

This program can dramatically reduce utility, and large industry demands for petroleum for powering peaking turbines at 30% efficiency and other new generating capacity additions while providing high efficiency and lower costs than alternative solutions.

References

1. Flavin, C.,"Electricity's Future: The Shift to Efficiency and Small Scale Power," Worldwatch Institute, 1985.
2. Sissine, F., "Fuel Cells for Electric Power Production: Future Potential, Federal Role and Policy Options," Congressional Research Service, Report # 85-523 SPR, January 1985.

APPENDIX II

SUPPLEMENTAL QUESTIONS AND ANSWERS FOR THE RECORD

THE ERICKSON GROUP

The Honorable Marilyn Lloyd
Chairman
Subcommittee on Energy
Research and Production
Suite 2321 Rayburn HOB
Washington, DC 20515

April 2nd, 1985

APR 5 1985

Dear Chairman Lloyd,

Thank you for your kind letter of March 25th, 1985.I was happy to be able to respond to your invitation to testify before your subcommittee, and am pleased that the day appeared to be both informative and constructive.

In response to the questions attached to your letter, I am replying as follows:

- Should the DOE be subject to anti-trust restraints ?

I believe that the anti-trust restraints are an essential feature of our economic system, and that their principles should be taken into account in any competitive situation. However, we are dealing with a GOVERNMENT MONOPOLY at the present time, and this gives us hope that we should be able to depend upon this government to exercise sound ethics and diligence in their pursuit of the marketplace. Although we must strive for fair prices for the customers, we must also protect the profits that the taxpayer is owed for the investment that has been made in the Enterprise. Competition is needed to encourage efficiency and the benefits of lower prices, while maintaining profits. Anti-trust is intended to blow away the cobwebs and help the consumer. Since we do not have commercial competition, the government must provide both the diligence required and the pressure toward economy and cost control.

- Did the Panel evaluate the Enterprise strictly commercially ?

Yes. There was no attempt to review legal or statutory aspects. The Panel concentrated on enrichment matters, and did not look at mining or waste, nor the maintenance of a viable industry.

- Did the Panel have members, or hear from people, out of the supply industry ?

No.

I hope these answers will be of use to you in completing the testimony.

Sincerely,

Clive G. Whittenbury
511 Trinity Ave
Yuba City, California 95991

P.O BOX 30, MARYSVILLE, CALIFORNIA 95901 (916) 743-0703

Lawrence Livermore National Laboratory

April 16, 1985

The Honorable Marilyn Lloyd, Chairman
Subcommittee on Energy Research and Production
Committee on Science and Technology
Suite 2321 Rayburn House Office Building
Washington, D.C. 20515

Dear Mrs. Lloyd:

Thank you for the opportunity to respond to the supplemental questions for the record. My responses follow:

Q. Isn't it true that technological uncertainty is translated into economic or cost uncertainty relative to the process?

A. It is true that technological uncertainty leads to cost uncertainty. To reduce both the AVLIS and AGC technological uncertainty prior to production plant construction, DOE estimates FY86 through FY88 R&D expenditures of $454M and $894M, respectively.

Q. In terms of percentage completion toward the stage where a confident decision can be made on the best technology, how would you rate AVLIS and AGC?

A. I believe by May 1985 sufficient information will be available to the Process Evaluation Board to clearly choose the better of the two processes--AGC or AVLIS. The data available will allow an accurate relative ranking of cost and risk between the two processes. However, to accurately determine the absolute cost (rather than relative cost) of either process will require full scale demonstrations under plant prototypic conditions where life cycle operating costs can be proven.

Sincerely yours,

John L. Emmett

John L. Emmett
Associate Director for Lasers

vjm

An Equal Opportunity Employer • University of California • P.O. Box 808 Livermore, California 94550 • Telephone (415) 422-1100 • Twx 910-386-8339 UCLLL LVMR

MARTIN MARIETTA ENERGY SYSTEMS, INC.

GEORGE R. JASNY
VICE PRESIDENT ENGINEERING & COMPUTER SERVICES

POST OFFICE BOX Y
OAK RIDGE, TENNESSEE 37831
(615) 574-3761

April 15, 1985

Ms. Debbie Johnson
Subcommittee Office
B-374 Rayburn House Office Building
Washington, D.C. 20515

Dear Ms. Johnson:

In her March 25, 1985, letter Congresswoman Marilyn Lloyd asked that I respond to four questions as a supplement to the February 28, 1985, Subcommittee hearing on the FY 1986 DOE authorization request for the Uranium Enrichment program. The responses to these questions are enclosed.

Sincerely,

George R. Jasny
Vice President

GRJ:nv

Enclosure

Answers to Questions Submitted to G. R. Jasny by Marilyn Lloyd,
Chairman, Subcommittee on Energy Research and Production

Question:

What is the cost of a SWU from the Oak Ridge gaseous diffusion plant? Is that the same as an incremental cost of an additional SWU produced at the Oak Ridge plant? If not what is that incremental cost?

Answer:

The average cost of a SWU from the Oak Ridge plant is the total cost of all factory operations, divided by the number of SWUs produced in the accounting period. The average cost at any plant is strongly influenced by the volume of production over which to spread the relatively fixed costs of having the plant ready to operate. For 1984 the Oak Ridge average costs are shown in the following table.

OAK RIDGE GASEOUS DIFFUSION PLANT

	FY 84 12 Months Costs	2.93 Million SWU Produced
	$SWU	$ Millions
Total Production Costs	$131.17	$384.2
Depreciation	7.94	23.2
	123.23	361.0
Unused TVA Demand Charges	32.63	95.6
	90.60	265.4
Used TVA Demand Charges	20.67	60.5
Energy and Other Operating	69.93	204.9
Other Operating, etc.	16.30	47.8
Energy	$ 53.63/SWU	$157.1

The incremental cost is the extra expense of producing one more SWU, or the savings from producing one less SWU, instead of the reference number of SWUs. In the diffusion plants the incremental cost is almost entirely the extra electric energy to make the extra product. At the TVA firm contract energy prices of $25/MWH, the Oak Ridge incremental SWU cost is from $50 to $60/SWU over the range of power utilization levels expected. By purchasing $18/MWH energy on an unfirm power agreement, the incremental cost falls to $36 to $43/SWU. The range of costs at a site depends upon the effects of the power level assigned on plant efficiencies.

Since the other plants have slightly lower power costs, they are assigned more production, which allows their fixed costs to be spread over more SWUs, so a separate accounting makes them look even more economical.

Question:

Have you discovered any technological roadblocks which would prevent a deployment decision for either the AVLIS or AGC technology?

Answer:

No. However, there are unanswered questions concerning scale-up, capacity, and reliability all of which will affect SWU cost. Since the only reason for deploying either technology is reduced cost, no deployment decision should be made until the answers to these questions are reasonably in hand.

Question:

If you were to categorize the percentage of development completed for each of the two advanced technologies, what percentage would you ascribe to AVLIS and to AGC?

Answer:

This is very difficult to assess. On the basis of the ratio of R&D dollars expended to those projected, it would appear that AVLIS development is approximately 60 percent completed while AGC development is approximately 75 to 80 percent completed. This may not be a good measure and does not include reliability demonstration.

Question:

Have Martin Marietta and DOE instituted or begun consideration of any plan to re-train or to provide assistance in finding alternative employment for the employees that will be affected by the technology selection decision? If not, why not?

Answer:

Martin Marietta and DOE are painfully aware of the needs to assist employees who might be impacted by the technology selection decision. The current reductions resulting from the decrease in funding for the centrifuge program have already caused us to address the matter of retraining and alternative employment for affected employees. The actions we have taken will also be applicable to those affected by the technology selection. Specifically,

a. We are making every effort to fill vacancies at the other two Martin Marietta Energy Systems' facilities in Oak Ridge with personnel impacted by employment reductions in enrichment R&D activities.

b. We have implemented programs to cross-train those surplus hourly employees to permit them to fill vacancies at other Energy Systems' plants such as the increased security requirements at Y-12.

c. Within the past month, meetings have been held with Roane State Community College representatives to evaluate programs for upgrading the skills of electricians to permit them to fill future openings in computer repair technologies. We have assigned a coordinator, representing the Y-12 facility, to work closely with Roane State and DOE officials in this matter.

d. In addition to the items indicated above, we have initiated programs for the interchange of job openings with all other major elements of Martin Marietta Corporation outside of Oak Ridge; and we have developed detailed plans for an outplacement center which will provide professional assistance, resume preparation, access to all available job listings from all major employment centers, assistance in typing, distribution, and follow-up of applications by impacted employees, and, in general, counseling services to maximize the possibility of employment to those who must be removed from the Energy Systems' staff.

MARTIN MARIETTA

MARTIN MARIETTA ENERGY SYSTEMS, INC.

POST OFFICE BOX P
OAK RIDGE, TENNESSEE 37831

April 16, 1985

Honorable Marilyn Lloyd, Chairman
Subcommittee on Energy Research and Production
House Committee on Science and Technology
B-374 Rayburn House Office Building
Washington, D.C. 20515

Dear Madam Chairman:

Re: Response to Six Questions to Supplement My Testimony at the Subcommittee Hearing on February 28, 1985

I am enclosing the response to the subject questions as you requested, and I appreciate the opportunity to testify before your committee.

Sincerely,

K. W. Sommerfeld
Vice President Enrichment - Centrifuge

/db

Enclosure

cc/enc: R. L. Grant, Boeing Engineering Company Southeast, Inc.
C. C. Hopkins, Martin Marietta Energy Systems, Inc.
J. R. Longenecker, Department of Energy Headquarters
C. J. Rowan, AiResearch Manufacturing Company
N. E. Whitchurch, Goodyear Aerospace Corporation
File - KWS

QUESTIONS

1. Have you discovered any technological roadblocks which would prevent a deployment decision for the AGC technology?

I do not believe that there are any technological roadblocks preventing a deployment decision for the Advanced Gas Centrifuge technology. Remaining problems are engineering-type problems rather than development or research problems. It is planned that the Advanced Gas Centrifuge Program fabricate and test a reasonable number of machines to provide a reliability base and to help assure that the engineering solutions are indeed appropriate to give Department of Energy high confidence in machine performance and cost prior to a final deployment decision and a major procurement action relating to deployment.

2. If you were to categorize the percentage of development completed for each of the two advanced technologies, what percentage would you ascribe to AVLIS and to AGC?

It is difficult to assign a specific percentage to each technology; however, it is important to note that the Advanced Gas Centrifuge is the only new element of the enrichment process at Portsmouth. All of the full-size rotating components of the machine have been prequalified for development testing. Remaining process components have been used for many years in the gaseous diffusion process.

The Advanced Gas Centrifuge therefore is a significant upgrading of a single element, the machine, in the overall enrichment process. Currently, that machine and its associated components have been demonstrated at approximately 75-80% of the program goals. The AVLIS technology on the other hand involves a whole new approach to uranium enrichment. My understanding of the work to date indicates that it is focused principally on two areas of the technology, the first being the separator technology, involving the various physics principles of photoionization. The second area involves the design and operation of high-powered laser systems required by the process. Although significant progress has been made in each of these areas, I am not aware of any integrated systems demonstration of the entire process which has been conducted to date. I believe that the AVLIS program plan currently identifies this type of experiment be conducted in FY 87.

3. Have Martin Marietta and DOE instituted or begun consideration of any plan to retrain or to provide assistance in finding alternative employment for the employees that will be affected by the technology selection decision? If not, why not?

Martin Marietta Energy Systems, Inc., has a very active job placement program designed to minimize the impact of the previously announced enrichment programmatic changes and budget reduction. We plan to continue these efforts to assist employees who may be affected by the technology selection decision.

These activities include:

- o Placement of affected employees in other organizations within Martin Marietta Energy Systems. (A considerable number have already been placed at the Y-12 Plant and the Oak Ridge National Laboratory.)
- o Plans to make affected employees available for other Martin Marietta Corporation openings.
- o A voluntary reduction-in-force program designed to allow certain employees to voluntarily terminate (with severance pay), thus saving the jobs of affected employees.
- o A comprehensive outplacement program has been developed which will provide affected employees with counseling, financial planning, job hunting techniques, interviewing skills, resume preparation, and contacts with other companies.

In addition to the placement efforts, Martin Marietta Energy Systems is actively working with Tennessee state officials and academic institutions to develop plans for retraining affected employees. Some needs have already been identified through the Dislocation and Retraining Program under Title III of the Job Training and Partnership Acts, and additional opportunities for retraining will be examined.

4. Is the material for the advanced rotors sufficiently reproducible in terms of its physical characteristics to assure a reliable and continuous production of advanced machines? You may provide a classified response to this question, if necessary.

   The material for the advanced rotors is currently purchased from commercial suppliers. In the past year, these suppliers have made significant progress in improving the physical characteristics of their material relating to Advanced Gas Centrifuge technology. We are informed by these suppliers that they are confident of meeting Advanced Gas Centrifuge specification requirements on a routine production basis within the next six months. The suppliers also state that adequate production capacity currently exists for early production quantities but capacity expansions requiring 15-18 months to achieve would be necessary to support program requirements for full scale deployment schedules.

5. Have the prototype Set V machines achieved the goals set for speed and reliability? If not, what have they achieved?

   Currently, the Advanced Gas Centrifuge Program has prequalified for development proposes all development components at speeds required by the Advanced Gas Centrifuge Program. We are at this time beginning to operate a full prototype machine approaching 85-90% of the speeds specified by the program. It should be noted that the program goals for performance as it relates to speed and capability do not call for a demonstration of these characteristics until the summer of 1986. With respect to the reliability program, the current program plans call for reliability testing of a full-size machine to begin in late 1986 following the complete prototype demonstration. The extent and duration of reliability testing will be determined by the performance of these machines and the degree of confidence required by Department of Energy prior to a full-scale deployment commitment.

6. Can the Set V machines be ready for deployment sooner than the date when the Department of Energy plans to deploy them, if the AGC technology is selected over the AVLIS technology?

The Advanced Gas Centrifuge team has proposed a program plan with major deployment beginning in April 1988 consistent with available revenue generated by separative work sales. The Department of Energy has not established an official deployment schedule nor have they disapproved the proposed Advanced Gas Centrifuge plan. The decision concerning readiness for deployment is a complex question which involves (a) the degree of reliability assurance the Department of Energy would like to have; (b) the business conditions of the market place; (c) the available revenues; (d) the anticipated status of foreign competitors; (e) the competitiveness of the gaseous diffusion plants.

These are dynamic circumstances which interrelate and make it very difficult to give a specific answer. It is the intent of the Advanced Gas Centrifuge Program to fully develop and demonstrate this technology as rapidly as possible to provide DOE with the maximum flexibility to compete effectively in the international enrichment market place and to operate the enrichment enterprise in a business manner.

BOEING ENGINEERING COMPANY SOUTHEAST, INC.
767 BOEING ROAD
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RICHARD L. GRANT
PRESIDENT

April 15, 1985

Dear Marilyn:

As requested in your letter of March 25, attached is my response to the additional nine questions posed by your Subcommittee concerning my testimony of February 28.

I appreciate the opportunity to appear before your Subcommittee and to elaborate on that testimony by the attached response.

Thank you for your personal efforts on behalf of the Uranium Enrichment Program and its vital role in our Nation's energy policy.

Sincerely,

Dick Grant

The Honorable Marilyn Lloyd
U.S. House of Representatives
Rayburn House Office Building
Washington, D. C. 20515

Enclosure:
As stated

A SUBSIDIARY OF THE BOEING COMPANY

1. Question

Is the material for the advanced rotors sufficiently reproducible in terms of its physical characteristics to assure a reliable and continuous production of advanced machines? You may provide a classified response to this question, if necessary.

Answer

The physical characteristics of the Set V rotor materials have evolved sufficiently to provide design margins adequate to account for normal expected material variations. The principal challenge in this regard is to assure that manufacturing variables are well under control. We believe we know how to control these variables as our mature statistical process control has proven. Some specifics are included in a classified response forwarded under separate cover.

2. Question

Have the prototype Set V machines achieved the goals set for speed and reliability?

Answer

Set V speeds have been achieved, reliability is subject to demonstrations and interpretations as discussed in the answers to Question 5. Test data is being obtained continually in Boeing and other development facilities which I believe to be a solid evidence of the performance we may expect for Set V centrifuges. This evidence is being used to refine and perfect performance in each succeeding test. No flaw has been identified which has not yielded to engineering expertise. There is no evidence that the Set V centrifuge will not meet its speed, reliability and performance objectives.

3. Question

Can the Set V machines be ready for deployment sooner than the date when the Department of Energy plans to deploy them, if the AGC technology is selected over the AVLIS technology?

Answer

The answer to this question depends, to a slight extent, on what has become an overly specific definition of what constitutes "Set V." Boeing is convinced that totally suitable and acceptable performance Set V-type machines could be deployed beginning as early as mid-1986 if planning and preparation were started immediately. The earliest of these machines may not meet all the Set V goals. They would, however, be significantly better than Set III performance. Production would evolve to machines which did meet or exceed Set V goals over a period of about 18 months. This approach would be cost-effective and competitive and would provide for maximizing the useful product obtained from funds expended in the near term.

Specific early, deployable and cost-effective performance might be 2.25 to 2.5 times the Set III performance as compared to the Set V goal of 3.0 times the Set III performance.

4. Question

What do you believe are the liabilities of the government to your company in the event that DOE decides to choose the AVLIS process over the AGC process? Do you expect to seek reimbursement for any of the company funds expended on the centrifuge process for the Government?

Answer

Boeing has provided the funds for all land, facilities and equipment utilized on the DOE Centrifuge Manufacturing Program. As a condition of bidding the RFP for a Phase 1 manufacturing task, we were required to obtain a resolution of The Boeing Company Board of Directors stipulating that we would provide the necessary resources for the conduct of Phase 1 as well as those necessary for Phase 2 performance (as then defined) if we were selected as one of two contractors to proceed into Phase 2. Only the Special Purpose tooling and equipment were segregated from the total resources. Although Boeing would provide the funding for design, procurement and/or manufacture of the Special Purpose items, DOE would become liable for the unamortized balance of the cost of that tooling and equipment if not selected to continue into Phase 2 in a competition with the other two centrifuge manufacturers. The unamortized balance is currently estimated at $14.5M.

Clearly, the overall program we are working to today is not that which was proposed and awarded as Phase 1 in September 1979. If AVLIS were to be selected as the technology to be deployed, Boeing will not have been afforded the opportunity of competing with the other two centrifuge manufacturers for continued viability of its investment. The question of liability for other tangible resources provided in good faith by Boeing, and the liability for returning or modifying to suitable condition for other use, is a legal and contract matter I am not competent to address.

Boeing and others involved in the centrifuge program have brought something of value to DOE both tangible and intangible. It is difficult to contemplate simply walking away from the significant investment, commitment and dedication the Government/Industry team has created. I believe the Nation, the DOE, the utilities and all the citizens who comprise these categories will not be best served by a choice which terminates the centrifuge program.

5. Question

Leaving aside the question of whether comments on the other technology is permitted within the Process Evaluation Board (PEB) non-disclosure agreement that all participants signed, and which we noted you adhered to, Dr. Emmett has stated that the economic validation of the Set V centrifuge cannot be conducted without running a quantity of rotors for a large fraction of the proposed 5 to 10 year life on which the economics are predicated.

We are very concerned that not only the PEB but also the Congress have available the best possible data on which to base some critical funding and policy decisions. Is it in fact necessary to run a quantity of Set V rotors for the alleged 5 to 10 year period? And if not, why?

Answer

It is indeed an unusual approach to suggest that the useful, economic lifetime of a system or component can only be established to an acceptable confidence level by operating the system or component for the time period which is required in operational practice. To accept this thesis suggests that operational deployment of many of the modern technology based things we accept and use in today's world should still be awaiting the results of tests.

Analysis and testing of relatively short duration produce reliable estimates of useful life and economics. These same techniques also project maintenance and refurbishment which further enhances useful life and economics. Further, as deployed, operational systems accumulate operating life and experience, it is normal for economic means to be developed for extending useful life even beyond that predicted in the development stage.

The AGC is not unique in these regards. A time period of one year of operating experience would be totally adequate and even this time period should not be spent without making the necessary preparations, emplacing equipment and manufacturing centrifuges for operational deployment. Production centrifuges should be in assembly by the end of the above one-year period.

6. Question

The Secretary of Energy in December, upon a recommendation from the PEB and others, decided to disapprove a request for long lead items and a Request for Proposal (RFP) for a bridge quantity of machines. He cited significant technical and economic risks as the basis for that decision.

You are an engineer and businessman whose corporation has a great deal of its own money invested in this project and which has as much experience in technology development and commercialization as any in the country. What is your view on whether there is "significant technical risk" in moving forward rapidly to deploy Set V centrifuges in GCEP?

Answer

It is my opinion that the technical and economic risks are very small. That is not to say that every technical problem is solved at this instant in time.

I must first point out that the technical and economic risk was cited as a reason not to start actions which would lead to production and deployment. The total long-lead authority denied was $6M for materials and $22M for special purpose equipment. The reason for the term "long lead" is that suppliers will require 8 to 12 months to supply the materials; up to 18 months for the Special Purpose Equipment. In addition, Boeing, Goodyear and Garrett all agreed to pay the $22M in Special Purpose Equipment costs under the same terms as our Phase 1 contracts so that the outlay to DOE would be the $6M for materials and some small portion of the $22M; perhaps $3M each year, beginning in FY1986. For the above reasons, the amount at "risk" in this decision would not exceed $9M.

As a practical matter, the long-lead authorization would not have produced any centrifuges. It would, however, have resulted in protecting the ability to produce centrifuges early and efficiently.

On the central issue of technical and economic risk, it is my opinion that the risks cited and those implied are very low. Much lower than those taken in many commercial ventures of less complexity and technical content. That is not to say that all technical problems for AGC are totally resolved at this instant in time. They are, however, sufficiently resolved, demonstrated to be amenable to engineering solutions and shown to provide attractive economics even if full Set V performance were not achieved. The risk is, in my view, acceptably low to justify preparing for early deployment and certainly low enough to warrant the small price of protecting the option to deploy in the earliest and most efficient manner possible.

7. Question

You stated in your testimony that "There will undoubtedly be something better on the horizon at all times" when discussing the relationship between manufacturing technology and science-based technology. Is it a correct interpretation of your comment that you are suggesting that improvements will be realized on the Set V machine to make it even more efficient in the future?

Answer

Maturity of technology does not suggest obsolescence. Technologies evolve and improve once put in operation and their full potential is seldom known when first deployed. This will certainly be the case for AGC. We have only begun to understand the full capability. Operational experience and materials improvements (already expected) will result in improvements. Efficiencies could grow by 25 to 30 percent.

It is also true that some new technology will always be on the horizon with proponents who proclaim its superiority. The opportunity to wait for something superior will always be with us. Availing ourselves of this opportunity will only result in eternal waiting.

8. Question

If you could do what you felt was necesary to put the Set V program on the best business-like track, when could you have Set V installation, operation and production of separative work?

and specifically:

-When would the Set V operate at design levels?

-What is your plan for the Set III's already in GCEP?

-Would your program live within the budget constraints that apparently are limiting flexibility now?

Answer

My opinion of the best track for the AGC program includes earliest possible operation of the Set III centrifuges already manufactured. These should be operated in the most economical way possible to obtain their useful product. This operation would include minimum refurbishment of these machines and only to the extent of utilization of those spares already available or available upon completion of currently contracted manufacturing.

The next step and in parallel with start of Set III operation would be to commence manufacture of Set V-type machines. These machines would not have full Set V performance but would be much better than Set III. Performance of 2.0 to 2.5 times Set III should be expected. The first of these could be available for installation in the 3rd quarter of FY1986. The first process building at Portsmouth will be one-half occupied by Set III machines at this time. Installation of the interim Set V machines would proceed in the remaining half of this first process building.

Testing and development would proceed toward full Set V demonstration with production transitioned from the interim to the final design configuration such that machines of full Set V performance could begin installation not later than mid to late 1987. I estimate that not more than 1500 of the interim Set Vs could be fabricated by this time. Therefore, the full Set V performance machines would continue installation to fill the first process building and would fill the second process building. Retrofit of the first portions of the first process building with full Set V performance machines would proceed as economically and operationally appropriate.

The capacity of the first process building before retrofit would be 2 million SWU per year and the second would add 3.3 million SWU per year for a total of about 5.3 million SWU/year.

In the meantime, the planning and construction of third and fourth process buildings can proceed as paced by all the factors at work in the enrichment marketplace.

The above approach would live within the budget constraints as I know them.

9. Question

You testified that you believe the centrifuge enrichment program represents the best way to meet the DOE enterprise goals and that it offers a cost-effective hedge against, among other things, foreign exchange rates. Will you elaborate on this for the Committee?

Answer

Over the past 5 years, foreign exchange rates have caused the Deutsch Mark to go from 55 cents to 33 cents and the French Franc from 22 cents to 10 cents. These are the principal currencies of DOE's foreign competition in the uranium enrichment marketplace. Based on prices offered in U. S. dollars by both URENCO and EURODIF then and today, their prices have actually grown substantially as measured in their currencies while declining in ours.

This influence can lead to a paradox of logic and planning as relates to competitive pricing. If exchange rates were to reverse their trend, DOE can become competitive, at least in the near term, without price reduction. Other factors such as technology implementation and/or electric power cost advantages could become important but are not likely to be available to the competition for a number of years. On the other hand, the strength of the Dollar could continue to grow in such a way that foreign supplier pricing, in dollars, could always beat the U. S. price.

Trying to chase the competitive pricing because of exchange rate is a very difficult task and one that may be impossible if the trend is unfavorable to the Dollar. It is, however, reasonable to pursue the lowest cost approach to enrichment at the earliest possible time regardless of exchange rate. This approach permits the best opportunity to price competitively and the best opportunity to decide price/cost relationships in a volatile currency and demand marketplace environment.

The past years have demonstrated that our ability to predict long-range uranium enrichment demand was very imprecise. The recent past suggests that our predictions of competitive prices were equally imprecise. While demand predictions are undoubtedly more stable and reliable today, there is little to suggest that our ability to project long-range costs and competitive prices is much improved.

It is, therefore, my opinion that the best strategy is to proceed toward the lowest cost production possible, decoupled to the maximum extent from those parameters which history suggests are the most volatile upward, with the best chance of early and certain cost reduction and with the best, earliest flexibility for pricing decisions. I believe the Centrifuge Program offers the best chance of pursuing this strategy with the least risk.

GOODYEAR AEROSPACE
CORPORATION
AKRON, OHIO 44315

EXECUTIVE OFFICES

April 10, 1985

The Honorable Marilyn Lloyd
U.S. House of Representatives
Subcommittee on Energy Research & Production
Suite 2321 Rayburn House Office Building
Washington, DC 20515

Dear Madam Chairman:

I am pleased to provide the following answers to the questions in your letter of March 25, 1985:

- **Is the material for the advanced rotors sufficiently reproducible in terms of its physical characteristics to assure a reliable and continuous production of advanced machines? You may provide a classified response to this question, if necessary.**

  Yes, the material for the advanced rotors is sufficiently reproducible in all characteristics to assure a reliable machine and to support continuous production of advanced machines. Two material suppliers have been under contract since June, 1984 to make process refinements for the purpose of meeting the specifications for the new rotor material. One supplier has already demonstrated the ability to meet the specifications, and the second is well along toward demonstrating this. Early contract negotiations are under way with both suppliers to assure the availability of fully qualified material for production of advanced rotors.

- **Have the prototype Set V machines achieved the goals set for speed and reliability?**

  Our plan has always been structured to follow a step-wise, systematic testing/optimization sequence to achieve Set V goals for speed and reliability. To date the goals for both speed and reliability have been met in accordance with this plan.

  The speed goal to be met by the first week of April, 1985 was set at 87% of the Set V design speed. We have met this goal in our demonstrations and we know of at least two other program participants who have met this goal.

  The next step is to achieve 100% of Set V design speed. We have every confidence this will be achieved. In fact, rotor balancing to 100% of the Set V design speed has already been demonstrated.

Reliability goals apply to raw materials, parts, assemblies and the complete Set V machine. Tests to date on raw materials, parts, assemblies and the prototype machines have consistently confirmed our ability to meet the Set V goals. For example, the following critical rotor subassemblies have been tested and verified to meet the technical criteria established for the Set V reliability goals:

Rotor tube raw materials;
Rotor tube;
Rotor end assemblies.

The operating characteristics of demonstration machines running at 87% of Set V design speed also confirm the ability to meet the goal at 100% design speed.

o **Can the Set V machines be ready for deployment sooner than the date when the Department of Energy plans to deploy them, if the AGC technology is selected over the AVLIS technology?**

Yes, the Set V machines can be ready for deployment sooner than the current date when the Department of Energy plans to deploy them. The remaining engineering and testing to be done on Set V machines are not significant enough to delay a deployment decision.

The Set V machine is based on more than 25 years of development and a solid base of proven, full-scale production and operations technology. Test results continue to confirm the Set V performance goals can be met. Fabrication experience has confirmed our ability to manufacture the new, more cost-effective Set V machines using production processes and equipments proven on the Set III machines. Operating experience in the GCEP plant has been outstanding and has proven that the plant design and the plant control systems are sound, safe, reliable and ready.

Early deployment of the Set V machines is required to:

- Protect our national security and interests by avoiding dependence on foreign energy sources.

- Defeat the inroads of foreign competition, thereby avoiding the loss of U.S. jobs and worsening of our balance of trade.

- Provide a low-cost, assured source of domestic uranium enrichment while avoiding the layoff of production workers and the added cost of restarting centrifuge production.

- Provide for the recovery of the $2.6 billion of taxpayers' funds already invested in GCEP.

- **What do you believe are the liabilities of the government to your company in the event that DOE decides to choose the AVLIS process over the AGC process? Do you expect to seek reimbursement for any of the company funds expended on the centrifuge process for the government?**

In the event DOE chooses the AVLIS process over the AGC, we believe the following is a viable, economically attractive approach:

Install Set V centrifuges in at least two, preferably four, process buildings at the GCEP site in Portsmouth, Ohio. This provides the following benefits:

- Go-forward costs for SWU's produced at the GCEP site would be significantly cheaper than SWU's produced by the GDP's, even when recent GDP cost projections involving the possible use of some amount of "interruptable" power are considered.
- Four process buildings of Set V centrifuges at GCEP would lower the enterprise average SWU production cost to the $40/SWU range. In addition, GCEP costs would be much less susceptable to future unanticipated increases in electricity costs and GCEP would conserve enormous amounts of energy.
- By their own timetable, AVLIS cannot be deployed until the mid 1990's. By installing the Set V centrifuges in GCEP in the late 80's, DOE would be taking timely action to maintain and strengthen customer confidence and to prevent the further inroads of foreign competition.
- DOE would receive a financial return on the $2.6 billion sunk costs for GCEP.
- The GCEP facility can be used to economically re-process stored tails and/or to provide higher levels of enrichment needed for defense needs as a back-up for the current facility.
- The GCEP plant would provide a backup capability in the event AVLIS proves to be unacceptable, and could be used to replace all of the obsolete GDP capacity by deploying additional process buildings.

With regard to government liabilities and our intent to seek reimbursement for company funds expended on the centrifuge process in the event AVLIS is chosen, we will seek reimbursement for the unamortized book value of special assets, as covered by our current production contract, plus the normal close down costs after completion of our current production and R&D contracts. These close down costs include such items as disposition of inventories and government owned property, disposition of hazardous and/or classified equipments and waste, decommissioning and restoration of facilities, and relocation and/or layoff of personnel. We estimate these costs to be in excess of $23 million. These costs do not include GAC's "lost opportunity" costs during this time period.

Thank you for the opportunity to present our views to your Subcommittee. We appreciate your continued interest and support of the uranium enrichment program. If you have any questions regarding the enclosed information, please call me.

Sincerely,

E. O. Hartig
Vice President

GARRETT

AiResearch Manufacturing Company
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In reply refer to:
57601-29474-014

April 10, 1985

Ms. Marilyn Lloyd
Chairman, Subcommittee on
Energy Research and Production
U.S. House of Representatives
Committee on Science and Technology
Suite 2321 Rayburn House Office Building
Washington, D. C. 20515

Reference: Your letter dated March 25, 1985

Dear Mrs. Lloyd:

Your letter of March 25 posed four additional sets of questions for which AiResearch comments were requested in connection with the FY 1986 DOE uranium enrichment program authorization request. Our response to your inquiries is enclosed.

We will continue to offer our assistance for your Subcommittee's activities in connection with the uranium enrichment program. We certainly appreciate all your personal efforts and those of your staff and colleagues in pursuing a very responsible Congressional direction to this vital United States enterprise.

Sincerely,

AIRESEARCH MANUFACTURING COMPANY
A Division of The Garrett Corporation

Rowan

C. J. Rowan
Director
Enrichment Systems

CJR:lss
Enclosure

cc: Mr. J. P. Eagleson/Garrett WDC

AIRESEARCH RESPONSE TO 3/25/85 ADDITIONAL QUESTIONS FROM SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION, MARILYN LLOYD, CHAIRMAN

Question 1

Is the material for the advanced rotors sufficiently reproducible in terms of its physical characteristics to assure a reliable and continuous production of advanced machines? You may provide a classified response to this question, if necessary.

Answer

Materials for the advanced rotors are presently undergoing a series of manufacturing process control changes and improvements. The objective is to narrow significantly the variability of physical properties currently being experienced. At the same time, materials sample testing, component, and whole machine evaluation are providing the necessary data to establish the firm requirements for materials specifications. The supplying vendors are well aware of the evolution of the specifications governing physical property characteristics and tolerances. Both they and we are confident of their ability to consistently produce the needed quantities of material to specification requirements and to do so in the time frame governed by current planning schedules.

It is important to keep in mind that the advanced gas centrifuge program is using materials commercially available now but originally intended by the suppliers for other applications. The vendors had no need to control their manufacturing tolerances in the areas important for centrifuge application. Now that they know the centrifuge technical requirements, they are proceeding to implement process changes which will assure consistent control of physical characteristics. A related class of start-up challenges were encountered in the production of rotor materials for the earlier Set III model centrifuge. These were similar to P-3 materials problems and were rapidly solved by the suppliers as their volume production facilities and quality control systems were brought on line. We fully expect the same kind of learning experience to prevail quickly for P-3 material suppliers.

Question 2

Have the prototype Set V machines achieved the goals set for speed and reliability?

Answer

The prototype Set V rotors have achieved the goals set for operating speed, as well as overspeed testing conditions consistent with available material properties. Complete centrifuge machines have operated at 99% of the operating speed range planned for the P-3 production centrifuge. Operation at full-speed will occur very soon. Improved materials have been received which will permit development qualification testing of rotor parts for full speed operation. High-speed testing at the component, subsystem, and whole machine system level has been exceptionally successful throughout the past six-to-nine month period, not only at AiResearch but at other contractor facilities as well.

AIRESEARCH RESPONSE TO 3/25/85 ADDITIONAL QUESTIONS FROM SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION, MARILYN LLOYD, CHAIRMAN

Question 2 (Cont)

The prototype Set V machine reliability has attained the goals set for the development program, as demonstrated by the development qualification program for the machine components. The reliability of production units will be demonstrated in a test program planned for FY 1986, provided long-lead funding is approved by DOE for this group of machines in FY 1985. This well-structured test program will result in the rapid accumulation of a significant number of machine test hours in both 1986 and 1987 which will provide a high degree of assurance that Set V production machines will meet or exceed their plant operational reliability requirement. Both performance and reliability targets will be demonstrated prior to quantity production manufacturing.

Question 3

Can the Set V machines be ready for deployment sooner than the date when the Department of Energy plans to deploy them, if the AGC technology is selected over the AVLIS technology?

Answer

The Department of Energy has not defined an official deployment plan for the Set V AGC machine. As you know, the May, 1985 technology selection does not constitute a deployment decision, according to the stated DOE policy. A proposed deployment plan for AGC was authorized in December, 1984, however, for use as part of the current DOE technology selection process proceedings. The AGC proponents required a reference deployment plan baseline for presenting their technical and economic supporting data to the DOE Process Evaluation Board. This paper deployment plan for the P-3, if adopted, would result in an approximately two-year centrifuge production interruption at a minimum.

We think it is possible to prevent such an extensive production interruption through a controlled conversion from Set III to Set V at the centrifuge manufacturers and the GCEP plant site. This controlled conversion process would allow initial Set V machine deliveries to begin very early in 1986 and ramp-up through the year to achieve rates similar to the moderate rates prevailing for the Set III machines. The wrenching effects of an extended production interruption would thereby be avoided, valuable production learning experience preserved, and provision maintained for a highly competitive supply base to achieve DOE's enrichment enterprise economic objectives.

Question 4

What do you believe are the liabilities of the Government to your company in the event that DOE decides to chose the AVLIS process over the AGC process? Do you expect to seek reimbursement for any of the company funds expended on the centrifuge process for the Government?

AIRESEARCH RESPONSE TO 3/25/85 ADDITIONAL QUESTIONS FROM SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION, MARILYN LLOYD, CHAIRMAN

Answer (To Question 4)

The Government has both a financial and moral responsibility which must be considered in the selection process for choosing an advanced enrichment technology. Financial responsibilities are clearly defined by the AGC participants' contracts. Specifically, cost which the Government is contractually obligated to reimburse Garrett in the event the AGC program is terminated includes:

1. Orderly termination and closeout of production work in Sandusky, Ohio and Torrance, California.
2. Production facility restoration at both sites.
3. Reimbursement of unamortized special equipment.
4. Orderly termination and closeout of development activity at Torrance, California.
5. Development facility restoration and property disposal at the Torrance site.
6. Orderly termination and closeout bringing both engineering and any residual production tasks to a logical closure of all such activity. Additional tasks of a managerial and administrative nature will also be conducted to satisfy health, safety, and security requirements and related matters.

Of a more subjective nature is the moral obligation the Government has incurred over the last 20 years during development of the advanced enrichment technology industry. During this period, major development and production contractors, such as Garrett, have invested over $200 million of company funds and committed its most talented human resources. We, along with other leading U.S. industrial firms, have been encouraged for these many years to make major commitments in order to develop an industrial base for the Department of Energy. The positive centrifuge industry response that resulted provided the U.S. Government a needed flexibility in dealing with the long-term enrichment perspective and extended planning horizon inherent in a commercially oriented nuclear enterprise devoted predominantly to supporting electric power utilities.

This substantial industrial base has been supportive of DOE and has provided resources which permitted the Government increased flexibility in dealing with changing policy direction as well as the implementation of both short- and long-term business strategies demanded by the highly competitive uranium enrichment market place. This industrial base is capable of satisfying a wide range of Government plant modernization alternatives for replacing high-cost, obsolete capacity. The AGC industrial base has the ability to mitigate market risk and meet government fiscal funding constraints by modular deployment of the AGC process and private financial participation. The Government itself has also made a substantial investment in the form of the nearly $3 billion in sunk costs

AIRESEARCH RESPONSE TO 3/25/85 ADDITIONAL QUESTIONS FROM SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION, MARILYN LLOYD, CHAIRMAN

Question 4 (Cont)

for the GCEP facility in Ohio. The partnership which has developed over the last 20 years between industry and Government does not differ from typical business relationships evolved in private industry where parties contribute both to human and financial resources over an extended period of time while pursuing mutual goals.

We do not seek reimbursement of company funds expended in pursuit of our mutual goals in the uranium enrichment enterprise, other than those cited above for which DOE has a contractual responsibility. However, truncation of a highly successful enrichment technology program because of near-term budgeting problems unique to a Government-owned enterprise and done at the expense of a viable enrichment plant modernization requirement necessary for retention of U.S. leadership and competitiveness in the international supply of nuclear fuel services, seems wanting in managerial probity if it should occur. A DOE decision in favor of long-term enrichment enterprise viability being dependent upon the outcome of a 10-year future high-risk development program on AVLIS, combined with a gamble on expected long-term containment of cost-sensitive electric power purchases for aging diffusion plants, is an unacceptable risk to the enterprise and cannot be endorsed by industry as a mutual goal. We hope and expect that DOE will not choose this path, that sound management sense will prevail, and that the numerous and obvious benefits in AGC will be recognized for their exceptional value to the U.S. enrichment enterprise and promptly acted upon in terms of both technology selection and deployment.

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March 20, 1985

The Honorable Marilyn Lloyd
Chairwoman, Energy Research and Production
Subcommittee
House Committee on Science and Technology
Washington, D.C. 20515

Subject: February 28, 1985 Hearings of the House Science and Technology Committee, Energy Research and Production Subcommittee on DOE's FY 86 Uranium Enrichment Budget Request

Dear Chairwoman Lloyd:

We appreciated very much the opportunity of giving testimony at the subject hearings. We were, however, quite upset at the testimony on AVLIS SWU pricing given by Dr. John Emmett of Lawrence Livermore National Lab (LLNL). Upon advising DOE of our concerns, we were encouraged to discuss the matter directly with you.

As you will recall, Dr. Emmett testified that the AVLIS process could provide separative work at a price of $25/SWU, plus or minus $10/SWU. He also mentioned a range of $15 to $40/SWU but put far greater emphasis on the $15/SWU end of that range and indicated that there was almost absolute assurance that these numbers would bracket the final SWU cost from AVLIS. Under direct questioning from you as to the ground rules under which these estimates were made, Dr. Emmett advised that the estimates were done per the PEB ground rules. This, in our opinion, is a clear misrepresentation of facts.

LLNL's own estimate to the PEB under PEB ground rules was $49/SWU without GCEP closeout costs, $54/SWU with GCEP closeout costs (the PEB ground rules require inclusion of these costs). I would also note that the centrifuge program team (CPT) presented much higher estimates of AVLIS costs to the PEB, specifically $120 to $160/SWU most optimistic range, $400 to $500/SWU most likely range. These figures are consistent, in our opinion, with varying estimates regarding AVLIS process physic and engineering designs and on the almost complete lack of integrated experimental data. Absolutely no data is available at full scale and full laser power.

In addition to this misrepresentation of AVLIS costs, the Livermore testimony also indicated that 2 million SWU/year of production capability can be on-line by 1993 based on an extremely optimistic schedule including parallel accomplishments of further R&D, engineering and construction activities. LLNL has been directed to a more serial schedule by the PEB and the figures cited in LLNL's testimony are not factual on a critically important point of scheduling.

We respectfully request that the record of the subject hearings reflect these facts. Thank you.

Sincerely,

Lawrence D. Huppert

Lawrence D. Huppert
Assistant to the Director
Enrichment Systems

LDH:hd

MITRE

10 May 1985 D17W-10

Ms. Marilyn Lloyd, Chairman
Subcommittee on Energy
Research & Production
Committee on Science and Technology
U.S. House of Representatives
Washington, D.C. 20515

Dear Ms. Lloyd:

Below is a question which was addressed to me along with my response.

Question:

Do you believe it is appropriate for the Federal Government to collect imputed interest on the government's money invested in the enrichment program? Since the government is only borrowing part of its budget, should imputed interest be limited to the percentage of the enrichment program equal to the percentage of borrowing necessary to meet the Federal budget?

Answer:

I believe the requirement to calculate imputed interest is an unnecessary and detrimental requirement for the Uranium Enrichment Program.

The program is already required to operate on a basis whereby outlays must match revenues. Under these circumstances, program managers cannot borrow funds or depend upon government supplements when planning R&D or other activities and imputed interest should not be charged. Otherwise the program receives a double penalty; it cannot borrow funds to allow optimum program expenditures and it must pay heavy interest penalties for past inefficiencies.

Sincerely,

Woody Cunningham

George W. Cunningham
Director
The MITRE Institute

GWC/cl

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BALTIMORE
GAS AND
ELECTRIC

CHARLES CENTER · P O BOX 1475 · BALTIMORE, MARYLAND 21203

ARTHUR E. LUNDVALL, JR
VICE PRESIDENT
SUPPLY

April10, 1985

The Honorable Marilyn Lloyd
Chairman Subcommittee on Energy
Research and Production
Committee on Science and Technology
U.S. House of Representatives
2321 Rayburn House Office Building
Washington, D.C. 20515

Dear Madam Chairman:

Thank you again for the opportunity to appear at your February 28, 1985 Subcommittee hearing on the FY 1986 DOE authorization request for the uranium enrichment program. I was very pleased to have that opportunity to represent the interests of the domestic uranium enrichment customers. We are pleased that congressional decision makers, such as yourself, seek comments from the DOE uranium enrichment customers. DOE customers have a unique role to play in providing views to Congress on the future of the uranium enrichment program. They are in the market attempting to minimize their nuclear fuel costs, and they have the responsibility to serve efficiently the electricity consumer who is, of course, the ultimate consumer of uranium enrichment services. This unique perspective on the DOE enrichment program is offered in an attempt to achieve a better overall national uranium enrichment enterprise.

Per your request, enclosed please find the answers to the questions posed in your March 25, 1985 letter. If you desire any further information, please do not hesitate to contact me.

Sincerely yours,

Arthur E. Lundvall Jr.

Enclosure

RESPONSES TO QUESTIONS
ARTHUR E. LUNDVALL
VICE PRESIDENT, BALTIMORE GAS & ELECTRIC COMPANY
AND
CHAIRMAN, NUCLEAR POWER EXECUTIVE ADVISORY COMMITTEE
EDISON ELECTRIC INSTITUTE
SUBMITTED TO
SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
Hearing Date: February 28, 1985
Questions Dated: March 25, 1985

Q. What percent of those customers retaining their option to purchase 30 percent of their enrichment needs from outside of DOE will procure their enrichment needs from the DOE?

A. It is very difficult to predict what percentage of DOE customers will fill their currently unfilled demand for enrichment service from DOE. This will depend very heavily on the future offers made by DOE and their competitors and on the condition of the enrichment market as perceived by the enrichment customers. Individual electric utilities apply their own business criteria for making determinations, such as when and where to purchase their unfilled enrichment services requirements. Not every enrichment customer converted to the US Contract and not every enrichment customer who converted is taking all of its requirements from DOE. Furthermore, those utilities that have unfilled enrichment requirements will be considering offers from all competitors to fill those needs. We believe that this is a very healthy situation, because it has created a competitive enrichment market that will force all suppliers, DOE included, to seek to provide the services on the most cost effective basis.

DOE has just released its incentive pricing proposal to its customers. While each utility must look to its own business judgment to determine if it will take advantage of the incentive pricing plan for its unfilled requirements, we endorse such an approach as part of the overall attempt to manage the program effectively and we believe that the plan will increase the percentage of the market that DOE now commands.

Q. Is it appropriate that there be stronger ties or connections between EEI and the DOE in reviewing the management of the program? If so, what additional interaction would you recommend?

A. We recommend DOE look for input specifically from the utilities who are DOE's customers. The vast majority of DOE's uranium enrichment customers are members of EEI, the national trade association of the investor-owned segment of the electric utility industry. Thus, EEI would be pleased to assist DOE in creating any program that may be needed to improve the ties between the utilities as a group and DOE. This would be in addition to DOE's ongoing business relationship contacts with its individual customers.

Q. In your testimony you are very complimentary of the recent changes DOE has made to the manner in which it manages the uranium enrichment program, especially the issuance of the Utility Services Contract. What is your reaction to the legal challenge to the Contract by a group of domestic uranium producers?

A. The domestic electric utility industry recognizes the advantages of having a domestic uranium supply industry as a reliable supplier for a substantial portion of our uranium requirements. Over the past fifteen years, the vast majority of the uranium used in this country has been of domestic origin. However, the future for contractual opportunities for all the current domestic suppliers is cloudy, at best, because lower cost uranium is available from foreign countries where the newly discovered and recently developed deposits have substantially greater reserves in higher concentrations than are found in the United States.

On December 28, 1984, the American Mining Congress wrote to Secretary Hodel regarding the viability of the domestic uranium supply industry. They said, in part, that "(s)upply and demand will, in some time period, reach a reasonable balance..." We agree with the American Mining Congress on this one point, because real uranium demand can be driven only by reactor needs. The softness in the uranium market is a result of reactor schedule slippages and cancellations and is completely unrelated to the US Contract.

Unfortunately, a small minority in the domestic uranium production industry has challenged the US Contract. They perceive a benefit from this challenge that simply doesn't exist and are risking a chaotic enrichment market, if they prevail, that will hurt everyone, including themselves.

The DOE enrichment program and the enrichment market must function independently from the issue of the competitiveness of the domestic uranium industry.

Q. In negotiating its new Utility Services Contract, do you consider the DOE has made its utility customers any promises about specific SWU prices in the future? Specifically, has there been any time history of prices that has been suggested that presents a future expectation to the utilities associated with the US Contract?

A. DOE made no promises except to be competitive. In negotiating the Utility Services Contracts, the Department of Energy made representations regarding its plans to bring future SWU prices down. This is based on its attempt to behave in a more business-like fashion, to control costs, and pursue future enrichment technologies, as appropriate. The specific contractual arrangement made was a ceiling price. DOE has established a ceiling price in its contracts of $135 per SWU, which can escalate only in accordance with a specific formula.

* * * *

4:10:84

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April 24, 1985

The Honorable Marilyn Lloyd
Chairman
Subcommittee on Energy
  Research & Production
Committee on Science & Technology
U.S. House of Representatives
Washington, D.C.   20515

Dear Madam Chairman:

On March 5, 1985, Bill Stevens, Chairman of the American Mining Congress (AMC) Uranium Policy Council, testified before your subcommittee in hearings on the Department of Energy's fiscal year 1986 authorization request for its uranium enrichment program.

Thereafter, you submitted certain questions for Mr. Stevens' response. The answers to those questions are enclosed.

If you have questions regarding Mr. Stevens' responses, or if AMC can be of further assistance to the subcommittee, please do not hesitate to call me (861-2876).

Sincerely,

Larry A. Boggs

Larry A. Boggs
Senior Counsel

Enclosure

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AMERICAN MINING CONGRESS
RESPONSES TO
HOUSE SCIENCE AND TECHNOLOGY COMMITTEE QUESTIONS

April 24, 1985

1. The Congress's Tri-Committee Advisory Panel and virtually every other advisory committee involved with the enrichment business has recommended that DOE try to operate the enrichment enterprise as a business. We recognize the limitations in this recommendation for any government agency; however, would it be a prudent business decision for the Department of Energy to undertake the activities and policies that you are advocating here?

Answer: Your question concerning "prudent business decision" with respect to the Department of Energy enrichment activities requires a brief explanation.

The U.S. government enrichment operation is, in fact, a government-owned domestic monoply that occupies a position in the market between the raw material supply (natural uranium) and its only market (reactor fuel).

The government enrichment enterprise is to the uranium industry as the refining industry is to crude oil production. If the government owned and operated all petroleum refineries, it would obviously be in a position to strongly influence the market for crude oil, and surely would have some charter requiring fair and competitive policies with respect to crude oil supply.

In the case of uranium enrichment, however, because its position to strongly influence the market for natural uranium is less understood by Congress and the public, the government has failed to treat the uranium production industry fairly and equitably. Instead, DOE has proposed a policy that focuses solely on short-run advantages to its enrichment enterprise at the expense of domestic uranium producers.

Moreover, the government has an option in operating the enrichment plants so as to use more uranium and receive lower enrichment revenue, or vice versa, through deciding on the level of depleted uranium tails. In recent years, the Department of Energy has utilized its monopoly position and the government uranium stockpile to increase enrichment revenues at a time of budget deficits, to the detriment of the natural uranium supply industry in the United States.

The American Mining Congress (AMC) believes that DOE has in essence defined "prudent business practice" as any practice that increases its market share of world-wide enrichment without respect for the impact of its decision on the uranium supply industry. Clearly, this is not an acceptable definition of prudent business practice for a government monopoly.

The AMC testimony before your committee emphasized the following enrichment policy changes:

1. Allow utilities to choose enrichment tails assays without surcharges and without arbitrary limits.

2. Stop sales of government-owned inventories during a period of uranium market depression.
3. Provide an incentive for domestic uranium producers in DOE's new "incentive price" enrichment contracts.

These policy changes would, in fact, be prudent long-term business decisions for the enrichment enterprise.

The present enrichment policy is operating without due regard for and in a manner detrimental to the maintenance of an assured supply of raw materials to process, and in a manner detrimental to the maintenance of long-term markets for its enrichment services. For a business, these would be serious fundamental concerns.

There are, as noted, limitations on recommendations that DOE operate its enrichment facilities more "as a business." DOE's enrichment enterprise remains a government entity that is instrumental in advancing and implementing U.S. government nuclear policies, particularly those involving nonproliferation.

The U.S. uranium industry has been a secure and dependable source of natural uranium feed for DOE's enrichment operations. Moreover, the domestic uranium industry is DOE's primary feedstock supplier. Damage to this upstream industry limits DOE's feed supplies, and places DOE in a position of dependence on insecure and undependable foreign supplier entities and governments. For example, the French government nuclear fuel company, Cogema, is the world's largest single producer of uranium and DOE's pricipal enrichment competitor. Cogema is offering uranium supply and enrichment as a market package, while DOE is enacting policies that are putting its primary supplier of uranium--the domestic uranium industry--out of business.

It makes eminent business sense for DOE to adopt policies that not only minimize harm to domestic uranium producers, but also enhance their viability. If this country loses its uranium supply base, enrichment business will increasingly move abroad. Other governments, such as Canada, already have "upgrade" policies that require U.S. purchasers of uranium to buy Canadian conversion services. If extended to include enrichment, DOE's enrichment business would be in serious jeopardy, and there would be little hope of persuading private enterprise to construct and operate U.S. enrichment facilities. AMC believes that this is one of the important reasons why U.S. policy has heretofore stressed the importance of maintaining a viable uranium industry.

Furthermore, it makes little sense for DOE to distribute the government's uranium stockpile at a price of $9 per pound when projections indicate that DOE will have to purchase additional uranium in a few years at a significnatly higher price. The General Accounting Office (GAO) has repeatedly questioned the wisdom of DOE's plans in this regard, most recently in testimony on March 21, 1985, before the Energy and Environment Subcommittee of the House Interior Committee.

AMC strongly supports a vigorous and efficient domestic uranium enrichment program. We believe our recommendations are consistent with this objective.

2. When the section of the Atomic Energy Act dealing with the viability of the uranium industry was passed in 1964, uranium was a scarcer commodity than it is today. Why should uranium continue to be considered a critical material requiring government support since there is obviously an abundant supply from friendly nations like Canada? Even if the "upgrade-in-Canada" (page 4 of your testimony) policy causes Canada to be "unreliable," couldn't the U.S. then rely on (1) the stockpile; (2) other suppliers, like Australia; and (3) restarting the domestic industry if that became necessary?

Answer: Uranium was not a scarcer commodity in 1964 when the original viability legislation was passed. The implication that scarcity was the principal reason for the 1964 viability law is not accurate. Indeed, the legislative history to the 1964 act states that "special nuclear materials and the source materials from which they are produced are no longer scarce."1/ Rather, Congress and the Atomic Energy Commission recognized that excessive production capacity and foreign competition (conditions similar to those found today) threatened the continued existence of the U.S. uranium industry. The viability language was passed not due to scarcity, but because "the maintenance of a viable domestic industry is an integral part of a sound nuclear industry and may, indeed, be closely intertwined with the defense and security interests of the United States."2/

Second, we do not regard, and do not claim, that the "upgrade-in-Canada" policy pursued by Canada causes Canada to be "unreliable." We note simply that it threatens the U.S. uranium conversion

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1/ Legislative History to the Private Ownership of Special Nuclear Materials Act of 1964.

2/ Ibid.

industry, and, if extended to enrichment, will threaten DOE's enrichment enterprise as well. Whether Canada is "unreliable" depends on one's assessment of other factors, such as allegations of Canadian participation in an international uranium cartel, Canada's previous unilateral moratorium on exports, Canada's restrictions on foreign ownership, and official mechanisms in place in Canada to control price and terms of uranium export contracts.

Question #2 is composed of two questions. The first is "why should uranium continue to be considered a critical material requiring government support, since there is obviously an abundant supply from friendly nations like Canada?" The short answer to this question is national security and energy independence (self-sufficiency). It is shortsighted and places the United States in a vulnerable position to become excessively dependent upon foreign sources of supply. We assume that Congress, and in particular, the Science Committee, earnestly supports a vigorous DOE enrichment enterprise and technology in order to avoid exactly such a dependence.

There are many additional facets to this question. Initially, it should be recognized that the United States did rely on Canada and South Africa for most of its uranium needs until the mid-1950s. This was viewed as unacceptable for security and energy independence reasons, and the decision was made to develop a domestic uranium supply industry. It is also noteworthy that Canada bars sales for military purposes. Since Australia does as well, loss of a domestic uranium industry would leave the United States substantially dependent upon Africa for future military uranium requirements. It is not clear that this is consistent with U.S. policy and interests. Moreover, Canada can reasonably be expected over time to profit-maximize in the fashion of a classic monopolist; i.e. Canada will charge as much for its uranium as possible without precipitating significant U.S. production.[3] The net effect of relying on Canada would accordingly be to export U.S. jobs to Canada without any significant reduction in the cost of nuclear fuel to U.S. utilities. Finally, as indicated in a recent report by Colorado Nuclear Corporation,[4] most of Canada's existing production capacity is already spoken for.

The second question asks why the United States cannot rely on (1) the stockpile; (2) other suppliers such as Australia, and (3) restarting the domestic industry if that became necessary. As to the stockpile, GAO has indicated that DOE is disposing of the stockpile and the United States may have to purchase uranium in a few years. Thus, the stockpile is a short-term and disappearing solution. As to other suppliers such as Australia, they are subject to the same or worse infirmities as Canada. Australia has embargoed France due to nuclear testing, controls its prices, restricts foreign ownership, prohibits military sales and flirts with phasing out uranium production _entirely_ for political reasons. As to other sources generally, Robert Rich, until recently the nuclear fuel manager for the Yankee Atomic utilities, is quoted in _Nuclear Fuel_ (February 4, 1985, at page 8) as follows:

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[3] See Campbell, Exhaustible Resources and Economic Growth: The Case of Uranium Mining in Saskatchewan, Discussion Paper No. 270 for the Economic Council of Canada at 60, 2, 53, 54, and passim (September 1984).

[4] Colorado Nuclear Corporation, Review and Critique of "United States Uranium Mining and Milling Industry" at vii (September 1984), attached as Appendix A to testimony of Dustin Garrow, Hearing before the Subcommittee on Energy and the Environment of the House Interior Committee, 99th Congress, 1st Sess. (March 21, 1985) ("Canadian production is largely committed to a variety of foreign countries and Canada might not want to divert any of these deliveries to the U.S. Short of such diversion, Canada would have to increase production, which takes time and would probably require a premium price.").

> When one considers that well over half of the western world's uranium resources are in areas that have been commonly characterized as politically unstable, there's a large potential for market disruption by political events.

As to restarting the U.S. industry, this will require considerable time and expense. Once existing mines are closed, it will be more expensive, and impossible in some cases, to reopen them. Costs will be much higher. At least four or five years will be required to restore capacity, to retrain the workforce and to obtain the necessary governmental permits. Moreover, it is unclear that private firms would again consider entering the U.S. uranium industry in the absence of firm, long-term commitments by the U.S. government and customers to purchase domestic uranium.

3. Isn't DOE's use of its stockpile to raise the operating tails level neutral on its impact on the mining industry since the customer must continue to supply uranium at the tails level that would otherwise have been applicable? The "split tails" system is merely a way for DOE to internally maximize the productivity of its operations, is it not?

Answer: The answer to the first question is "no" because, among other things, DOE arbitrarily constrains "the tails level that would otherwise have been applicable." This is accomplished by DOE's penalizing and limiting the choice of the enrichment tails assay that directly governs the amount of uranium the customer must supply to DOE enrichment plants. The answer to the second question is "absolutely not." Split tails has absolutely nothing to do with improving DOE efficiency or productivity. It is economically attractive to DOE only in that it permits the agency, through bookkeeping adjustments (principally based on below-market valuation of government assets), to maintain the appearance of reducing costs by utilizing uranium purchased in prior years in the place of relatively more expensive electricity paid for out of current revenues in order to produce enriched uranium. Although this lowers DOE costs and cash requirements, it effectively transfers uranium demand from private suppliers to DOE.

Department of Energy
Washington, D.C. 20585

April 12, 1985

Honorable Marilyn Lloyd
Subcommittee on Energy Research
and Production
Committee on Science and Technology
House of Representatives
Washington, D.C. 20515

Dear Madam Chairman:

On March 5, 1985, Acting Assistant Secretary James Vaughan appeared before the Science and Technology Subcommittee on Energy Research and Production to discuss the Fiscal Year 1986 authorization request for the Uranium Enrichment Program.

Following that hearing, you submitted written questions for our response to supplement the record. Enclosed are the answers to those questions, which also have been sent directly to the Committee.

If you have any questions, please call Ingrid Nelson or Cathy Hamilton of my staff on 252-4277. They will be happy to assist you.

Sincerely,

Robert G. Rabben
Assistant General Counsel
for Legislation

Enclosure

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March 25, 1985

Mr. James Vaughan
Acting Assistant Secretary
for Nuclear Energy
U.S. Department of Energy
Washington, D.C. 20585

Dear Mr. Vaughan:

Thank you for your excellent testimony at our March 5, 1985 Subcommittee hearing on the FY 1986 DOE authorization request for the Uranium Enrichment program.

We would like to supplement the record of the hearing with your responses to the attached questions. We would appreciate receiving your responses within three weeks from the date of this letter. Please forward this information to the Subcommittee office, B-374 Rayburn House Office Building, Washington, D.C. 20515, to the attention of Ms. Debbie Johnson.

I appreciate your cooperation in this matter.

Sincerely,

Marilyn Lloyd

MARILYN LLOYD, Chairman
Subcommittee on Energy
Research and Production

ML:dj
Attachment

Additional Questions for Mr. James Vaughan

- The General Accounting Office (GAO) has charged that the Department of Energy is not recovering its costs in the Uranium Enrichment program as required by the law. What is your view on the GAO's charges, and if you have a detailed written reply, would you please submit it for the record?

- Have you evaluated the potential for shutting down all or half of the Paducah or Portsmouth plants? Would you please provide any written studies of this option to the Subcommittee?

- If the Department must pay demand charges to the Tennessee Valley Authority (TVA) regardless of whether the plant operates or not, wouldn't the forward costs, so to speak, of operating the Oak Ridge plant be significantly less than the cost of operating the Paducah plant, considering that this forward cost is equal only to the energy charge from the TVA?

- Please specify the terms of the agreement you have reached with the TVA to reduce electricity costs for operating the Oak Ridge and Paducah Gaseous Diffusion Plants (GDPs).

- How much money is being saved under this new TVA/DOE agreement?

- Have you completed the interim working schedule for the remainder of this fiscal year and the next? We would like to obtain a better understanding of the DOE's production needs and inventory draw-down plans intu the future. Could you provide this information in the interim working schedule when it becomes available?

- If the centrifuge technology is not chosen for eventual deployment, how will the funds already spent for that program, that is the costs for centrifuge R&D and the Gas Centrifuge Enrichment Project (GCEP), be treated? Will they be recovered or will they be written off?

- If the centrifuge technology is selected for deployment, will any costs incurred in the program be written off as unrecoverable, thus reducing the price of centrifuge enrichment services?

  If AVLIS is selected for eventual deployment, have there been any costs identified in that process development program that will not be recovered from the customer?

  If no costs are expected to be written off relative to the advanced technologies or GCEP, is it your assessment that only forward costs required to carry out the deployment of either technology are appropriate for consideration in the selection process?

  If some costs may be written off, then how will the effect of writing off these sunk costs affect the decision between the advanced technologies?

- Please comment on the Congressional Budget Office studies, particularly the study on results of total enterprise costs for various scenarios. Were the results of these studies incorporated into your planning?

- What is the latest data on the cost of enrichment services, that is the total charge to the customer, that will result from the deployment of either advanced enrichment technology? We would like to know what the cost to the consumer will be of a deployment decision for AGC as opposed to AVLIS as compared with simply operating the diffusion plants. Has the DOE considered any intermediate options, such as a four-building GCEP followed by AVLIS plants? Please comment and provide comparative costs.

- The budget books are somewhat vague as to the amount of money you are requesting for the advanced technologies for the entire fiscal year. Would you please indicate the level of the request for these technologies; first, assuming that Advanced Gas Centrifuges (AGCs) win and second, assuming that Atomic Vapor Laser Isotope Separation (AVLIS) wins?

- What is the Department of Energy's (DOE's) market objective for the long-term in the uranium enrichment business, and what policies, plans and programs have you began to implement to achieve these objectives?

- Last year in the Committee report on the Uranium Enrichment program, the Committee directed the Secretary of Energy to prepare a comprehensive market survey and draft marketing plan to be provided with the next budget submission. Have you done such a study and plan?

- Would you identify the specific goals of the Department in reducing the future cost of enrichment services?

- The Congress' Tri-Committee Advisory Panel report was forwarded to you last year for consideration and to some extent, implementation. Please tell the Subcommittee what you have done to implement specific recommendations.

- The business advisory panel and others have frequently recommended that DOE operate the enrichment enterprise as a business. In view of the OMB's limitation on borrowing to finance capital projects, do you believe it may be important to establish either a federal corporation to run the business or a revolving fund to finance this business? If not, why not?

- Could you please explain why the enrichment enterprise did not receive revenues to cover approximately $381 million in the costs for FY 1984 and $102 million for FY 1985?

- Are we correct in assuming that the $4.6 million automatic data processing system described in the budget is not the same as the supercomputer that was eliminated by this Committee from the budget last year?

Minority Questions for Mr. James Vaughan

- Last week, we heard testimony from the Uranium Policy Council which outlined the substantial hardships the uranium supply industry is facing. What has DOE done in its enrichment planning to address and accommodate the concerns of the uranium mining industry?
- Please state the current (March 1) operational tails assay at each of DOE's uranium enrichment plants.
- Please state the total amount of uranium (in pounds of natural uranium as U308) from the federal stockpile used or expected to be used as "overfeed" (i.e., in split-tails operations) for each year from FY 1985 through FY 2000.
- Please indicate the expected economically optimal tails assay for AVLIS and AGC technologies assuming uranium priced at $30/pound U308, $40/pound U308, and $50/pound U308. State any other assumptions made in calculating the economically optimal tails assay.
- When does DOE expect to go to the market to purchase uranium for defense programs? How much uranium does DOE expect to purchase?

POST-HEARING QUESTIONS AND ANSWERS
RELATING TO THE
MARCH 5, 1985
HEARING BEFORE THE
HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION

WITNESS: JAMES W. VAUGHAN, JR.

ACTING ASSISTANT SECRETARY FOR NUCLEAR ENERGY

URANIUM ENRICHMENT

Question 1: The General Accounting Office (GAO) has charged that the Department of Energy is not recovering its costs in the Uranium Enrichment program as required by the law. What is your view on the GAO's charges, and if you have a detailed written reply, would you please submit it for the record?

Answer: DOE believes that its uranium enrichment pricing actions and its write-off of depreciation of the unused portion of the GDP's were consistent with the cost recovery provisions of the Atomic Energy Act, the uranium enrichment criteria, past pricing actions, and generally accepted accounting principles. At this time, the Department is, however, unable to comment in detail on the GAO report because of pending litigation against DOE filed by several mining companies which raises many of the same issues.

URANIUM ENRICHMENT

Question 2: Have you evaluated the potential for shutting down all or half of the Paducah or Portsmouth plants? Would you please provide any written studies of this option to the Subcommittee?

Answer: Shutting down half of the Paducah plant is not a realistic option for future operation of the GDP's. We would not expect a significant reduction in costs from closing half of that plant since most of the people currently on-site would be needed to operate the remaining. We are considering the economic feasibility of closing the Paducah plant or the portions of the Portsmouth plant used to produce low enriched uranium. A comprehensive study, which will consider which of the three plants should be shutdown first, is still in progress.

URANIUM ENRICHMENT

Question 3: If the Department must pay demand charges to the Tennessee Valley Authority (TVA) regardless of whether the plant operates or not, wouldn't the forward costs, so to speak, of operating the Oak Ridge plant be significantly less than the cost of operating the Paducah plant, considering that this forward cost is equal only to the energy charge from the TVA?

Answer: The "forward costs" would not necessarily favor the Oak Ridge plant. TVA is the sole supplier to the Oak Ridge plant while both TVA and Electric Energy, Inc. (EEI) supply the Paducah plant. EEI supplies 735 megawatts (MW) to the Paducah plant at a total cost (capacity and energy) of about 23.8 mills per kilowatt-hour as compared to the TVA firm energy at 24.8 mills per kilowatt-hour. These unit costs are in FY 1985 dollars. At any power level at Oak Ridge, and at any level above 735 MW at Paducah, the firm energy would be provided from TVA at 24.8 mills per kilowatt-hour. The actual cost of separative work produced would depend on the specific power levels at each plant and could favor either plant depending upon their relative power levels and opportunities to purchase power at less than firm power rates.

URANIUM ENRICHMENT

Question 4: Please specify the terms of the agreement you have reached with the TVA to reduce electricity costs for operating the Oak Ridge and Paducah Gaseous Diffusion Plants (GDPs).

Answer: In February 1985, DOE and TVA concluded Experimental Test Energy (ETE) agreements that provide for delivery to the Oak Ridge and Paducah plants of up to an FY 1985 total of 150 megawatt-years of energy.

Under these agreements, DOE will have the opportunity to conduct tests and evaluate the operating flexibility of its plants. TVA will have the opportunity to evaluate the usefulness of such flexible operating modes over a long-term period in helping to achieve a better application of electric power in the TVA region.

This ETE, which represents unfirm deliveries of energy, is expected to cost approximately 20 percent less on average than TVA firm energy.

URANIUM ENRICHMENT

Question 5: How much money is being saved under this new TVA/DOE agreement?

Answer: If DOE were to purchase the entire 150 megawatt-years of ETE, we estimate that we will save about $7 million compared to buying the energy at TVA's firm energy rate.

URANIUM ENRICHMENT

Question 6: Have you completed the interim working schedule for the remainder of this fiscal year and the next? We would like to obtain a better understanding of the DOE's production needs and inventory draw-down plans into the future. Could you provide this information in the interim working schedule when it becomes available?

Answer: Planned production and inventory levels for the next few years are:

		Uranium Inventories	
FY	Production* Millions of SWU	Enriched** Millions of SWU	Natural Millions of kg U
1985	10.4	16.5	41.6
1986	8.0-8.4	12.7-13.2	40.7-39.9
1987	8.0-8.6	9.8-10.9	40.3-38.1
1988	8.0-8.8	4.1-6.2	37.8-34.2
1989	11.7-13.3	3.7-3.8	25.2-25.0
1990	13.7	4.5	10.2-10

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* Production will vary slightly depending on whether or not GCEP is constructed.

** Based on an assumed transaction tails assay of 0.25 percent U-235 through FY 1989 and 0.23 percent U-235 in FY 1990.

URANIUM ENRICHMENT

Question 7:	If the centrifuge technology is not chosen for eventual deployment, how will the funds already spent for that program, that is the costs for centrifuge R&D and the Gas Centrifuge Enrichment Project (GCEP), be treated? Will they be recovered or will they be written off?
Answer:	Through FY 1984 we have spent about $2,272 million on GCEP and about $913 million on centrifuge R&D. The R&D and imputed interest costs on GCEP are being recovered annually. GCEP capital costs will be recovered through depreciation expenses once production begins. The treatment of the GCEP costs in the event centrifuge is not selected will be considered as an integral part of the May 1985 Enterprise Strategy. The recoverability of past investments, whether in centrifuge or AVLIS, is contingent on our ability to generate revenues and is not directy related to the technology selection. The amount of past investment is fixed and cannot be changed by making a technology selection. The marketplace and future market prices will determine our ability to recover past investments. In developing the Enterprise Strategy we will be attempting to maximize recovery of all past investments.

URANIUM ENRICHMENT

Question 8 (a): If the centrifuge technology is selected for deployment, will any costs incurred in the program be written off as unrecoverable, thus reducing the price of centrifuge enrichment services?

Answer: Our ability to recover past centrifuge investments is not directly related to the technology selection but to market conditions and the expected revenue stream. Our objective is to maximize the recovery of past investments.

URANIUM ENRICHMENT

Question 8 (b): If AVLIS is selected for eventual deployment, have there been any costs identified in that process development program that will not be recovered from the customer?

Answer: The costs in the AVLIS program to date have been limited to R&D expenditures. These costs, as is the case with centrifuge R&D, are being recovered as they are incurred. There is no outstanding investment in the AVLIS program.

URANIUM ENRICHMENT

Question 8 (c):	If no costs are expected to be written off relative to the advanced technologies or GCEP, is it your assessment that only forward costs required to carry out the deployment of either technology are appropriate for consideration in the selection process?
Answer:	The question of recoverability of past investments is of interest in the process selection, but the overriding concern is our assessment of forward costs. The Process Evaluation Board will be examining the technologies on the basis of forward costs as well as on the basis of including past and forward costs.

URANIUM ENRICHMENT

Question 8 (d): If some costs may be written off, then how will the effect of writing off these sunk costs affect the decision between the advanced technologies?

Answer: The question of recoverability of past investments is of interest in the process selection, but the overriding concern is our assessment of forward costs.

The Process Evaluation Board will be examining the technologies on the basis of forward costs as well as on the basis of including past and forward costs.

URANIUM ENRICHMENT

Question 9:	Please comment on the Congressional Budget Office studies, particularly the study on results of total enterprise costs for various scenarios. Were the results of these studies incorporated into your planning?
Answer:	The CBO issued two studies, October 1983 and September 1984, examining the centrifuge and AVLIS programs on a total enterprise cost basis. Both studies used then-current technology cost data (that we provided) as prepared by the technology advocates. The 1983 study favors the centrifuge technology slightly and the 1984 study showed the AVLIS technology to be slightly favored. The technology data used by CBO has been superceded by new cost data and therefore the conclusions reached by CBO may be altered by the final data generated in the process selection. The CBO studies were well done and appear to be an objective look at the issue. However, the CBO studies do not attempt to critique the costs or technology claims in the data supplied by the proponents of each process. This critique, which is key to any technology evaluation, is the formidable task now before the Process Evaluation Board (PEB).

URANIUM ENRICHMENT

Question 10 (a): What is the latest data on the cost of enrichment services, that is the total charge to the customer, that will result from the deployment of either advanced enrichment technology?

Answer: The current charge to the customer is $135 per SWU as announced on April 1, 1984.

The cost data used in developing that charge assumed deployment of the centrifuge technology. We selected centrifuge and GCEP because that technology (1) was previously assumed in setting prices and (2) presents a more capital intensive profile at least in the near term. We examined the resulting charges from AVLIS deployment at that time and found no significant price variance for 1985.

The cost data used was the best available in early 1984. As the data for both technologies is currently being revised as part of the technology selection, future price calculations will utilize the most current data.

URANIUM ENRICHMENT

Question 10 (b): We would like to know what the cost to the consumer will be of a deployment decision for AGC as opposed to AVLIS as compared with simply operating the diffusion plants.

Answer: Prices for FY 1986 and beyond will be developed as a part of the May 1985 Enterprise Strategy. The FY 1986 price will be announced after the technology selection and issuance of the Enterprise Strategy. The prices of deploying either AGC or AVLIS depends, obviously, on the estimated costs and timing of deployment. DOE would not plan to deploy either AGC or AVLIS until it has been demonstrated to be cheaper than continued operation of the GDP's.

In conducting the process selection, the Process Evaluation Board will be examining the potential price impact of deploying the AGC or AVLIS as compared to using only the diffusion plants.

URANIUM ENRICHMENT

Question 10 (c):	Has the DOE considered any intermediate options, such as a four-building GCEP followed by AVLIS plants? Please comment and provide comparative costs.
Answer:	In arriving at the May 1985 Enterprise Strategy, DOE is considering all reasonable options. However, a four-building GCEP followed by an AVLIS plant in the 1990's is probably not achievable because it requires continued research development funding of both technologies and construction funding for both. The available revenues do not appear to be sufficient to support this option. Comparative cost data on the options considered will be available in May 1985.

URANIUM ENRICHMENT

Question 11: The budget books are somewhat vague as to the amount of money you are requesting for the advanced technologies for the entire fiscal year. Would you please indicate the level of the request for these technologies; first, assuming that Advanced Gas Centrifuges (AGCs) win and second, assuming that Atomic Vapor Laser Isotope Separation (AVLIS) wins?

Answer: The FY 1986 budget proposes $150 million or roughly 10 percent of projected revenues to be expended on research and development. A specific allocation between winner/loser will not be made until the May 1985 selection. However, if a backup technology is carried we would plan to allocate between $100-$125 million to the winner and about $25 million to the loser.

The most recent deployment scenarios proposed by the technology advocates requested about $100 million for AGC in the case of a win and about $125 million for AVLIS. We are currently evaluating these deployment scenarios and will set the final budget mark in May.

URANIUM ENRICHMENT

Question 12: What is the Department of Energy's (DOE's) market objective for the long-term in the uranium enrichment business, and what policies, plans and programs have you began to implement to achieve these objectives?

Answer: DOE's primary objective is to remain competitive on price and terms in the international uranium enrichment market. It is our objective to: (1) maintain our existing customer base and to compete aggressively for new orders and for customer demand that is currently uncommitted to any supplier; (2) to pursue rigorous cost control and cost reduction in the program and to get our prices into the internationally competitive range as soon as possible; and (3) to operate all aspects of the enterprise in a businesslike manner and to continue to provide a secure source of supply in furtherance of Government nonproliferation objectives.

Over the past year, we have improved our marketing capability, achieved significant cost reductions in the operation of our facilities, made significant advances in our business planning, made significant advances in the development of new lower cost technologies, strengthened and streamlined our DOE management structure, and began the process of obtaining increased input from private sector sources on our business and financial practices.

URANIUM ENRICHMENT

Question 13: Last year in the Committee report on the Uranium Enrichment program, the Committee directed the Secretary of Energy to prepare a comprehensive market survey and draft marketing plan to be provided with the next budget submission. Have you done such a study and plan?

Answer: During the last year, DOE has taken actions to strengthen our marketing analysis and customer servicing capabilities. We utilized the services of a private marketing consultant and several private nuclear services firms to assist in our marketing planning. We strengthened the DOE marketing capability by increasing the number of staff involved in marketing and adopted an account executive system whereby a DOE account executive is assigned to each customer. We have improved our communications methods with our customers through the conduct of regional seminars, newsletters, and other forms of communication to assure that we are informing customers about recent developments in our programs and keeping in close touch with them regarding their current status and issues. We also have begun to draw on the extensive marketing resources of our principal contractors for advice and support in marketing.

Most recently, Martin Marietta Energy Systems has announced a reorganization of their Oak Ridge operation to provide for a marketing and business operations group

URANIUM ENRICHMENT

Answer 13 (continued): specifically dedicated to assisting DOE in improving its marketing and customer servicing capabilities.

We are continuing to evaluate our marketing strengths and weaknesses and will attempt to achieve further improvements during the next few years. A marketing plan is one of the deliverables due in May 1985.

URANIUM ENRICHMENT

Question 14: Would you identify the specific goals of the Department in reducing the future cost of enrichment services?

Answer: It is our objective to reduce our price as soon as possible to the internationally competitive range and to retain that cost competitiveness in the long term. Specifically, we plan to operate a mix of the existing GDP's in the most cost-effective manner possible and to introduce advanced technology in a timeframe that assures that: (1) our near-term price declines as rapidly as possible to competitive levels in the international marketplace; and (2) that advanced technology is brought on line in a timeframe that assures long term economic competitiveness.

URANIUM ENRICHMENT

Question 15: The Congress' Tri-Committee Advisory Panel report was forwarded to you last year for consideration and to some extent, implementation. Please tell the Subcommittee what you have done to implement specific recommendations.

Answer: The two summary recommendations of the panel were that DOE: (1) establish specific business and marketing objectives for the enterprise and build our enterprise strategy around them; and (2) focus the PEB activities in the May 1985 selection on key business factors as well as on technology comparison. The panel also made 15 specific recommendations ranging from marketing to our accounting to the conduct of our technology development programs.

During the last year, we have evaluated each of the Tri-Committee's recommendations and have taken appropriate actions to implement the recommendations and have met with the Panel members to discuss our implementation plans. With regard to their two major recommendations, we have 1) improved our marketing capability significantly, and 2) developed technology selection criteria that consider the requisite business factors in the May 1985 decision. Our selection factors and the PEB's approach to the technology selection have been reviewed with the Tri-Committee panel members on two occasions since our initial meeting last fall.

URANIUM ENRICHMENT

Answer 15
(continued): With regard to their other recommendations, we have:

- Consulted members of the panel in developing our investment and financial criteria for evaluating the advanced technology.
- We have heeded their advice on the conduct of our research and development programs, and have taken the necessary steps in cooperation with the program participants to revise and better focus our deployment plans for both AGC and AVLIS (including consideration of modular introduction of new capacity).
- We have initiated a review of alternative financial techniques for introduction of new capacity, and have studied methods by which we might obtain private sector financial participation in uranium enrichment.

In summary, we found the Tri-Committee Advisory Panel's recommendations very helpful, and we have developed action plans to implement them.

URANIUM ENRICHMENT

Question 16: The business advisory panel and others have frequently recommended that DOE operate the enrichment enterprise as a business. In view of the OMB's limitation on borrowing to finance capital projects, do you believe it may be important to establish either a federal corporation to run the business or a revolving fund to finance this business? If not, why not?

Answer: We are evaluating alternative means of organizing the enrichment enterprise and of financing any new technology project including the possibility of obtaining private sector financial support. We recognize fully that any decision to build new capacity must be predicated upon (1) our ability to bring the plant on line with high confidence in its projected cost and schedule, (2) a demonstrated ability of the advanced technology to lower our overall price, and (3) proof that the new capacity addition is a good investment and will have a reasonable payback period on the investment.

If we conclude that the enterprise can be operated more efficiently, or that the above conditions are met and we can deploy a new technology more economically, by organizing as a Government corporation or seeking authority to establish a revolving fund, we will recommend in our May 1985 strategy that these be pursued. In general, it appears that the flexibility afforded by a revolving fund to better manage cash flow is desirable.

URANIUM ENRICHMENT

Answer 16
(continued): If the Government is interested in attracting private investment, it also seems desirable to first organize as a Government corporation, or at a minimum more along corporation lines.

URANIUM ENRICHMENT

Question 17: Could you please explain why the enrichment enterprise did not receive revenues to cover approximately $381 million in the costs for FY 1984 and $102 million for FY 1985?

Answer: The $381 million difference in FY 1984 and $102 million difference in FY 1985 are the differences between the total amount originally appropriated by Congress and the revenues actually collected by the program.

The net appropriations in FY 1984 and FY 1985 have resulted from shortfalls in expected commercial and Government revenues. Commercial sales in recent years have been lower than anticipated because of increased competition from the secondary market and foreign competition. Government revenues have underrun estimates because requested funds to purchase enriched uranium for certain Government programs were not appropriated by the Congress. In fact, this accounts for the entire shortfall of $102.5 million in FY 1985.

In the Conference Report that accompanied the FY 1985 uranium enrichment appropriation, the Congress indicated that the Department is to obligate each year the full amount of the annual appropriation in operating the enrichment enterprise. Notwithstanding this language, we are reducing costs wherever possible and will not spend funds that are not absolutely required to support program

URANIUM ENRICHMENT

Answer 17
(continued): activities. In this regard, we are deferring $90.0 million from FY 1985 to FY 1986 as a result of savings achieved in enrichment power and construction activities. In addition, in FY 1984 the majority of the net appropriation of $380.8 million was not obligated and expended but was deferred for future use in the uranium enrichment account or for funding other Departmental programs. Thus we have, to the maximum extent possible, used these unobligated balances to offset program requirements, not to increase expenditures.

From the Department's point of view, the net appropriations are a temporary phenomena that the Department tried to correct by: (1) issuing the Utility Services (US) contracts, which have firmed up the revenue estimates; and (2) reducing costs, which should enable the Department to operate the program within revenue estimates in future years.

URANIUM ENRICHMENT

Question 18: Are we correct in assuming that the $4.6 million automatic data processing system described in the budget is not the same as the supercomputer that was eliminated by this Committee from the budget last year?

Answer: Yes, you are correct. The $4.6 million is not for the supercomputer you referred to. It is to purchase a system to replace a 13-year old IBM 360/195 computer that handles the classified general purpose workload (accounting, financial systems, inventories, etc.).

The age of the system and the availability of quality maintenance and replacement parts places DOE in an extremely vulnerable position. The vendor no longer makes replacement parts and has not supported the operating system since 1975. There are no other IBM 360/195's in the United States from which we can obtain used parts, and the quality of existing parts is suspect.

URANIUM ENRICHMENT

Question 19: Last week, we heard testimony from the Uranium Policy Council which outlined the substantial hardships the uranium supply industry is facing. What has DOE done in its enrichment planning to address and accommodate the concerns of the uranium mining industry?

Answer: We understand fully the hardships faced by the domestic uranium industry. The DOE enrichment enterprise faces the very same problems: overcapacity, large inventories, reduced demand, and severe price competition from subsidized foreign suppliers. The first phase of our strategy to improve the market position on the U.S. uranium industry, both uranium supply and enrichment sectors, is reflected in the issuance of a more competitive contract vehicle.

The objectives of this new contractual approach, the Utility Services (US) contracts, are to stabilize market share, reduce excess inventories, and increase the ability of the United States to compete with foreign suppliers. Customers representing over 90 percent of the existing enrichment sales base have converted to these individualized US contracts. To the extent DOE is successful in recapturing marketshare in the enrichment sector of the uranium market, the U.S. uranium supply sector has a greater opportunity to do likewise.

URANIUM ENRICHMENT

Question 19
(continued): We are also considering additional measures that would make us more competitive and permit an increase in our marketshare. Again, the more SWU demand DOE is able to capture, the more likely uranium feed supply will be of U.S. origin. Conversely, if SWU's are purchased from foreign suppliers, the probability of foreign uranium being purchased is greater.

In summary, DOE actions are intended to strengthen the competitive position of the entire U.S. uranium supply industry. We have worked closely with the domestic mining and milling industry throughout our commercial history, and we are committed to continuing to work closely with this sector to the extent good business practices permit. We believe DOE's strategy is the first step in laying the groundwork for a financially sound enrichment enterprise, and by so doing, will benefit utilities, rate paying customers, and the domestic mining and milling industry.

URANIUM ENRICHMENT

Question 20:	Please state the current (March 1) operational tails assay at each of DOE's uranium enrichment plants.
Answer:	At the beginning of March, the operational tails assay was 0.25 percent U-235 at Portsmouth, 0.30 percent U-235 at Paducah, and 0.56 percent U-235 at Oak Ridge. The Oak Ridge tails are being refed to the Paducah plant.

URANIUM ENRICHMENT

Question 21: Please state the total amount of uranium (in pounds of natural uranium as U308) from the federal stockpile used or expected to be used as "overfeed" (i.e., in split-tails operations) for each year from FY 1985 through FY 2000.

Answer: Based on previous operating plans, we project the need to overfeed about 26,500 tonnes of uranium (about 69 million pounds of U308) for civilian requirements through about 1991. We are currently re-evaluating our operating plan as part of the uranium enrichment enterprise strategy that will be forwarded to the Secretary for his approval. We will provide further information to the Committee when this work is completed.

URANIUM ENRICHMENT

Question 22: Please indicate the expected economically optimal tails assay for AVLIS and AGC technologies assuming uranium priced at $30 per pound U308, $40 per pound U308, and $50 per pound U308. State any other assumptions made in calculating the economically optimal tails assay.

Answer: The requested data are shown on the following table.

OPTIMUM TAILS ASSAY

	% U-235	
$/lb U308	AGC	AVLIS
30	0.160	0.130-0.154
40	0.137	0.109-0.131
50	0.120	0.094-0.114

The above were calculated using the latest cost estimates from the AGC and AVLIS proponents. AGC Set V technology deployed in GCEP is assumed to cost $43 per SWU. AVLIS proponents are designing two different extractor systems and their estimates range from $25 to $36 per SWU excluding research and development costs. For this analysis, a range of $30 to $40 per SWU was used for the AVLIS costs. The only other assumption used in the calculation was an assumed cost of $6.00 per kgU for conversion to uranium hexafluoride.

URANIUM ENRICHMENT

Question 23: When does DOE expect to go to the market to purchase uranium for defense programs? How much uranium does DOE expect to purchase?

Answer: It is not likely that DOE will purchase any natural uranium through this century. DOE has sufficient uranium resources in its enriched, natural and depleted inventories to economically meet currently projected defense needs for uranium through at least 2000.